STATE OF ILLINOIS
William G. Stratton, Governor
DEPARTMENT OF REGISTRATION AND EDUCATION
Vera M. Binks, Director

1960

GROUND-WATER GEOLOGY OF WINNEBAGO COUNTY, ILLINOIS

James E. Hackett

REPORT OF INVESTIGATIONS 213

ILLINOIS STATE GEOLOGICAL SURVEY

JOHN C. FRYE, *Chief*

URBANA, ILLINOIS

GROUND-WATER GEOLOGY OF WINNEBAGO COUNTY, ILLINOIS

James E. Hackett

Illinois State Geological Survey Report of Investigations 213
Urbana, Illinois **1960**

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Topographic mapping in cooperation with the United States Geological Survey

July 1, 1959

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ILLUSTRATIONS

GROUND-WATER GEOLOGY OF WINNEBAGO COUNTY, ILLINOIS

JAMES E. HACKETT

ABSTRACT

The geology of Winnebago County was studied to determine its relation to the occurrence and availability of ground-water supplies in the area.

Eleven bedrock formations, Precambrian, Cambrian, and Ordovician in age, are present. Glacial drift deposited during the Farmdale and Shelbyville ice advances of Wisconsin age overlie the bedrock, and the deeply cut bedrock valleys contain thick deposits of glacial outwash.

Four geohydrologic units were noted: the glacial drift aquifers of Pleistocene age; the dolomite aquifers of Ordovician age (the Galena, Decorah, and Platteville Formations, and the upper part of the Glenwood); the sandstone aquifers of Ordovician age (the St. Peter and the lower part of the Glenwood Formation); and the sandstone aquifers of Cambrian age (the Ironton-Galesville and Mt. Simon and the lower part of the Eau Claire Formation).

The Cambrian aquifers and the thick glacial outwash in the bedrock valleys are the main sources of water in the county and both are capable of supplying considerably more water than they do at present. They serve the larger industries and municipalities, whereas the sandstone aquifers of Ordovician age supply the smaller industries and cities. Water from the dolomite aquifers is used principally for domestic and stock supplies.

Maps and figures show the distribution and position of the rock types, buried valleys, and the availability of ground water from glacial drift.

INTRODUCTION

Winnebago County, in the center of the northern border of Illinois (fig. 1), has an area of about 529 square miles and, according to the 1950 census, ranks sixth in population in the state with a total of 152,385 persons.

Rockford, the principal city in the county and third largest in the state, has a population of more than 93,000. Other principal communities include Loves Park, South Beloit, Durand, Rockton, Pecatonica, and Winnebago (fig. 2).

Topographic maps by the United States Geological Survey are available for the Pecatonica, Rockford, Belvidere, Oregon, Kings, and Kirkland (15-minute) quadrangles, and for the Rockford and Camp Grant (7½-minute) quadrangles (pl. 1).

Purpose of Report

The geologic features of Winnebago County, which control, at least in part, the occurrence, movement, and availability of ground water, are described in this report and are interpreted in terms of their significance in evaluation of the ground-water resources.

The nature, sequence, and distribution of earth materials are the structural framework within which all hydrologic and water-quality data must be organized to obtain the best possible understanding of the ground-water resources of an area. To provide a logical and useful description of this framework it has been necessary to develop new and revised interpretations of the geologic record. It is hoped that this study will provide an adequate foundation for quantitative ground-water investigations and will encourage more detailed geologic studies in the area.

The maps and geologic descriptions are designed to be of use to water well contractors, consulting engineers, and others who are charged with the responsibility of developing new or extending existing

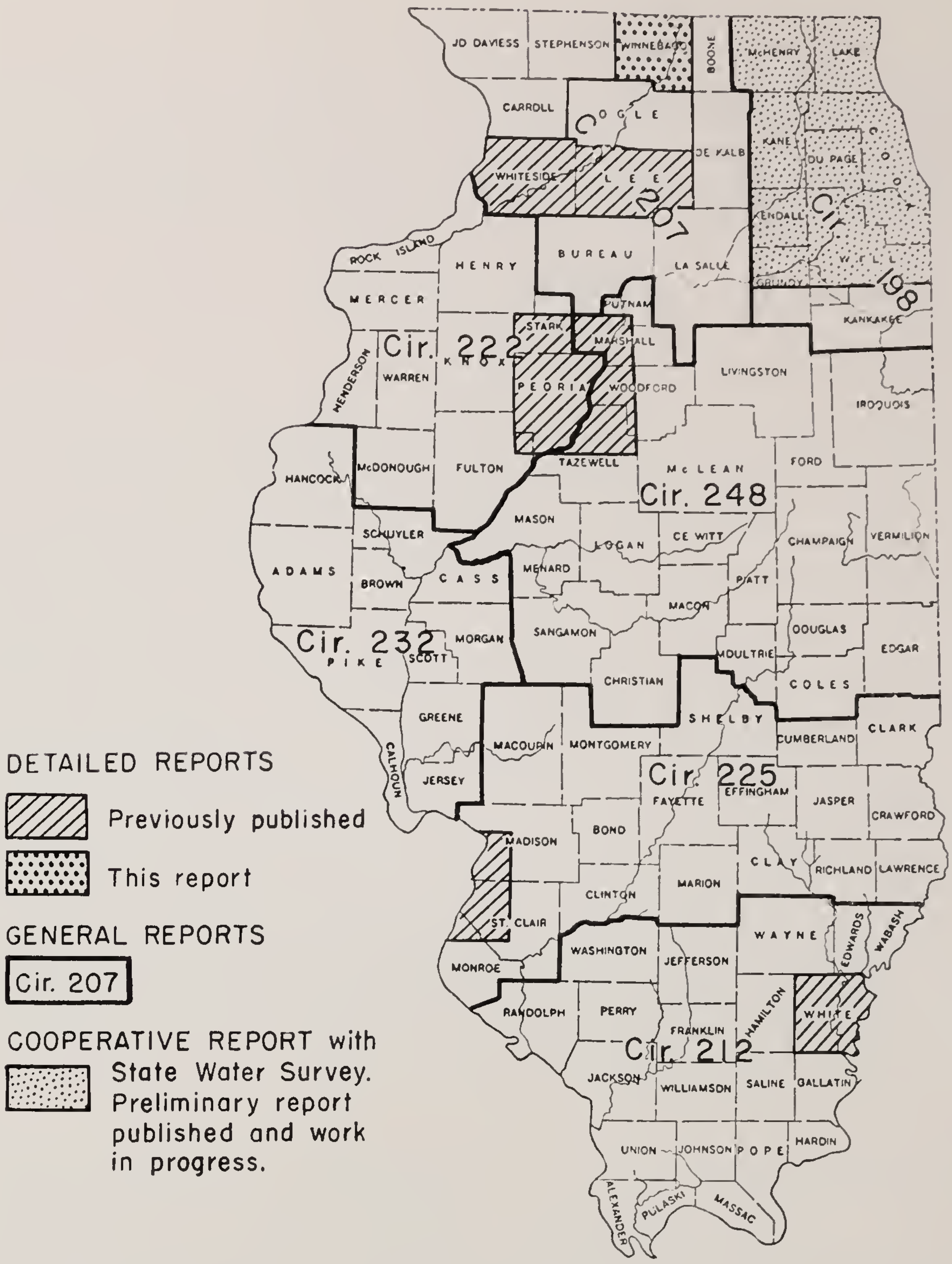


Fig. 1.—Index map showing areas covered by reports on ground-water geology.

ground-water supplies. Finally, the report should add to the knowledge of industrialists, municipal officials, and interested laymen concerned with ground-water development and conservation.

Subsurface Data

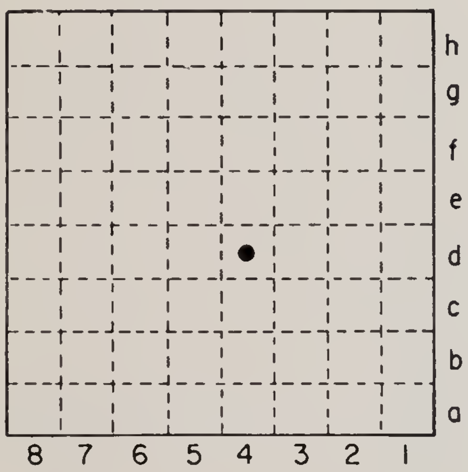
Approximately 600 well records were used in the interpretations contained in this report. Of this number, approximately 170 are records based on study of samples of drill cuttings obtained from test holes or well construction. Most of the remaining records are drillers logs provided by contractors. A few of the records are memory logs obtained in the field, which at best provide information only on depth to bedrock and depth to major lithologic units in the underlying bedrock.

Well-numbering System

The well-numbering system is based on the location of the well and uses the section, township, and range coordinate system of land survey. Variations of this method have been used for many years by the Illinois State Geological Survey in areal mapping to identify the location of outcrops.

The well number has five parts: county designation, township, range, and section numbers, and a number and letter that indicate the location of the well within the section. All sections are gridded at one-eighth mile intervals measured from the southeast corner of the section. Therefore, the area within each grid is equal to ten acres. Beginning from the southeast corner the grids (see diagram) are numbered from

east to west with arabic numerals and lettered from south to north with lower case letters. A normal section of one square mile is numbered from 1 to 8 and is lettered from a to h. If the section is longer or shorter than one mile, this variation is accounted for by the number of ten-acre grids that can be drawn within the section. A well drilled in the NW¼ NW¼ SE¼ sec. 30, T. 44 N., R. 2 E., Winnebago County, would be located within the section as shown in the accompanying diagram.



Winnebago County
T. 44 N., R. 2 E.
Sec. 30

Therefore, the well number for the example would be WIN 44N2E-30.4d. When more than one well falls within a ten-acre area, they are identified by arabic numbers after the lower case letter in the well number.

Acknowledgments

The cooperation of the many water well contractors and consulting engineers who provided most of the well logs and samples of drill cuttings on which the subsurface geologic interpretations used in this report were based is gratefully acknowledged. Industrial and municipal officials and other well owners also cooperated in providing information concerning water supplies.

I also am indebted to many present and former members of the Illinois State Geological Survey, particularly those of the Ground-Water Geology and Geophysical Exploration Section, for their assistance and cooperation in the study and in the preparation of the report. H. B. Willman of the Survey and Paul R. Shaffer of the University of Illinois provided valuable information on the basic geology of the area. Data on the economy of the area was compiled by Walter H. Voskuil. Richard R. Parizek made frequent field visits with the author, and Sisenando Samaniego and Jeanette Thornburgh Walters assisted in the processing of data.

The report is adapted from a doctoral dissertation submitted to the University of Illinois, which was based on research done at the Geological Survey.

GEOGRAPHY

Topography and Drainage

Winnebago County is within the Rock River Hill Country of northwestern Illinois (Leighton et al., 1948, fig. 1) and is characterized by broad, rolling uplands rising 100 to 200 feet above the alluviated valleys. Although the country lies well within the glacial border, the glacial deposits generally are thin and the surface of the underlying bedrock determines the major physiographic features.

The uplands have been extensively dissected by a well integrated drainage system and lack natural ponds, lakes, or sizable marshes. Although the local relief is pronounced, commonly in excess of 100 feet within one-half to three-fourths of a mile, the slopes generally are smooth and gentle enough to allow agricultural development. Locally, as along the Kishwaukee River and the lower part of the Rock River, the drainages occupy narrow, rock-walled valleys where the rugged, wooded slopes are unfavorable for agricultural development but add considerably to the beauty of the county.

Relatively level undissected divides occupy the uplands between the major and tributary valleys, and local relief generally does not exceed 40 feet. The divides rise gradually toward the northwest, and on the narrow divide north of the North Branch of Otter Creek in the extreme northwestern corner of the county the elevation of the land surface exceeds 990 feet. As the lowest elevation, in the valley of the Rock River where it leaves the county, is 680 feet, the maximum relief in the county is more than 310 feet.

The Rock, Pecatonica, and Kishwaukee River Valleys, the major drainage ways of

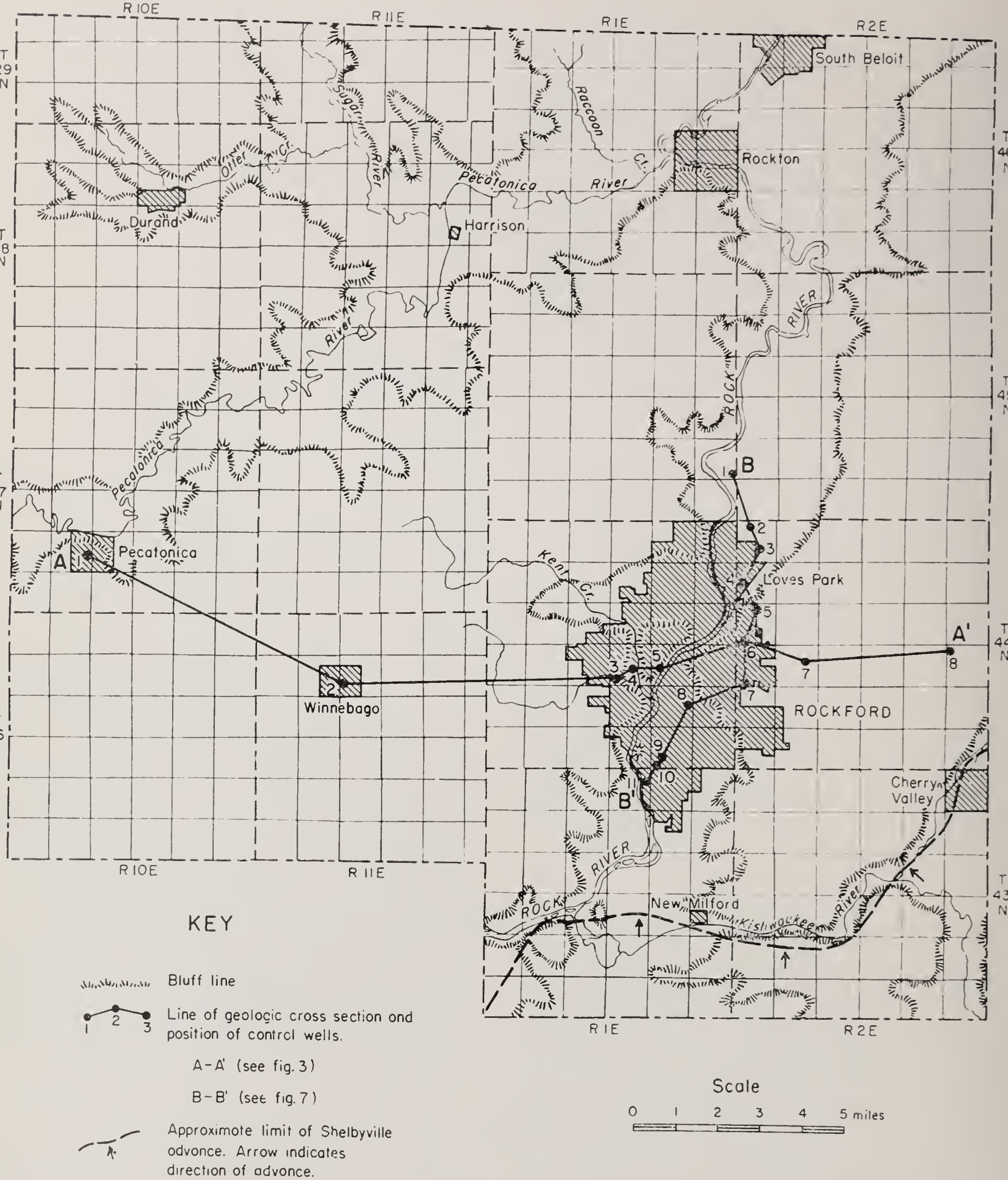


Fig. 2.—Principal geographic features of Winnebago County and location of cross sections.

the region, are the most outstanding features of the landscape and require separate description.

ROCK RIVER VALLEY

The Rock River enters the county from Wisconsin at South Beloit and flows generally southward within the eastern half of the county (fig. 2). North of the village of Rockton the river flows through a broad lowland more than 8 miles wide along the north county line. Southeast of Rockton the lowland gradually narrows until it becomes a river valley only 2 to 3 miles wide and continues thus for about 6 miles in the direction of Rockford. Near Rockford, the valley again narrows and in the northern part of the city is constricted to a width of

less than one-half mile. In the central and southern part of Rockford, the valley widens until it again is 2 to 3 miles wide.

Near its junction with the Kishwaukee River, the Rock River swings southwestward and abandons its broad valley to leave the county in a narrow rock-walled channel only slightly wider than the river. The broad, alluviated, and abandoned lowland continues southward from the junction and ends abruptly against morainal deposits just south of the county line.

The Rock River Valley is characterized not only by its variable width but by a relatively narrow floodplain. Between the floodplain and the valley walls, glacial outwash deposits of sand and gravel occur in terraces, in most places 40 to 50 feet above the level of the river. In the wider reaches of the valley, the terraces are broad and continuous and at places occupy more than 80 percent of the valley area. Along the valley from South Beloit to the junction of the Kishwaukee River numerous pits have been opened into these terraces for removal of sand and gravel.

PECATONICA RIVER VALLEY

The Pecatonica River enters Winnebago County just west of Pecatonica and flows northeastward to join the Rock River in the wide lowland near Rockton. In the western part of the county, southwest of the junction of the Pecatonica and Sugar Rivers near Harrison, the Pecatonica Valley is 1 to 2 miles wide. East of Harrison the valley widens to more than 2 miles (fig. 2).

The Pecatonica and Sugar River Valleys are characterized by a broad floodplain reaching from valley wall to valley wall. Over these broad bottomlands the Pecatonica and Sugar Rivers follow a sluggish, complicated course of numerous tight meanders. The bottomlands are scarred by many abandoned meanders, some of which are oxbow lakes. The older oxbows have slowly filled with vegetation and sediment and many of them now form arcuate marshes. The wide floodplain and meandering streams of the Pecatonica and Sugar River Valleys are underlain by fine-grained sediments, whereas the extensive terraces in the Rock River Valley are underlain by deposits of sand and gravel.

KISHWAUKEE RIVER VALLEY

The north and south branches of the Kishwaukee River enter southeastern Winnebago County and join in a large lowland about 2 miles west of the county line. At the junction the river enters a narrow rock-walled valley. At New Milford it leaves its narrow gorge to flow into the broad lowland that was abandoned by the Rock River. About 3 miles east of New Milford it joins the Rock River near the point where the Rock abandons its wider valley for a narrow rock-walled channel.

INDUSTRY

Winnebago County has a large industrial economy for which the availability of suitable ground-water supplies is an important element. The U. S. Bureau of the Census (1957, p. 112-5, 112-6, 112-18) reports that during 1954 there were 439 business establishments operating in Winnebago County, including the following major groups:

Industry group	*Number of establishments*
Machinery (except electrical)	141
Fabricated metal products	71
Food and kindred products	43
Printing and publishing	42
Furniture and fixtures	22
Primary metal industries	21
Stone, clay, and glass products	13
Transportation equipment	11

These establishments employed 38,194 persons in 1954, an increase of nearly 11 percent over the employment total for 1947, and their annual earnings totaled $177,-568,000. More than 92 percent of employees listed were employed in the city of Rockford and received annual pay of $162,956,000.

The estimated amount added to the county's economy by manufactures in 1954 was $312,770,000. Of the total number of persons employed, 29,318 were listed as production workers whose total annual wage was $124,101,000.

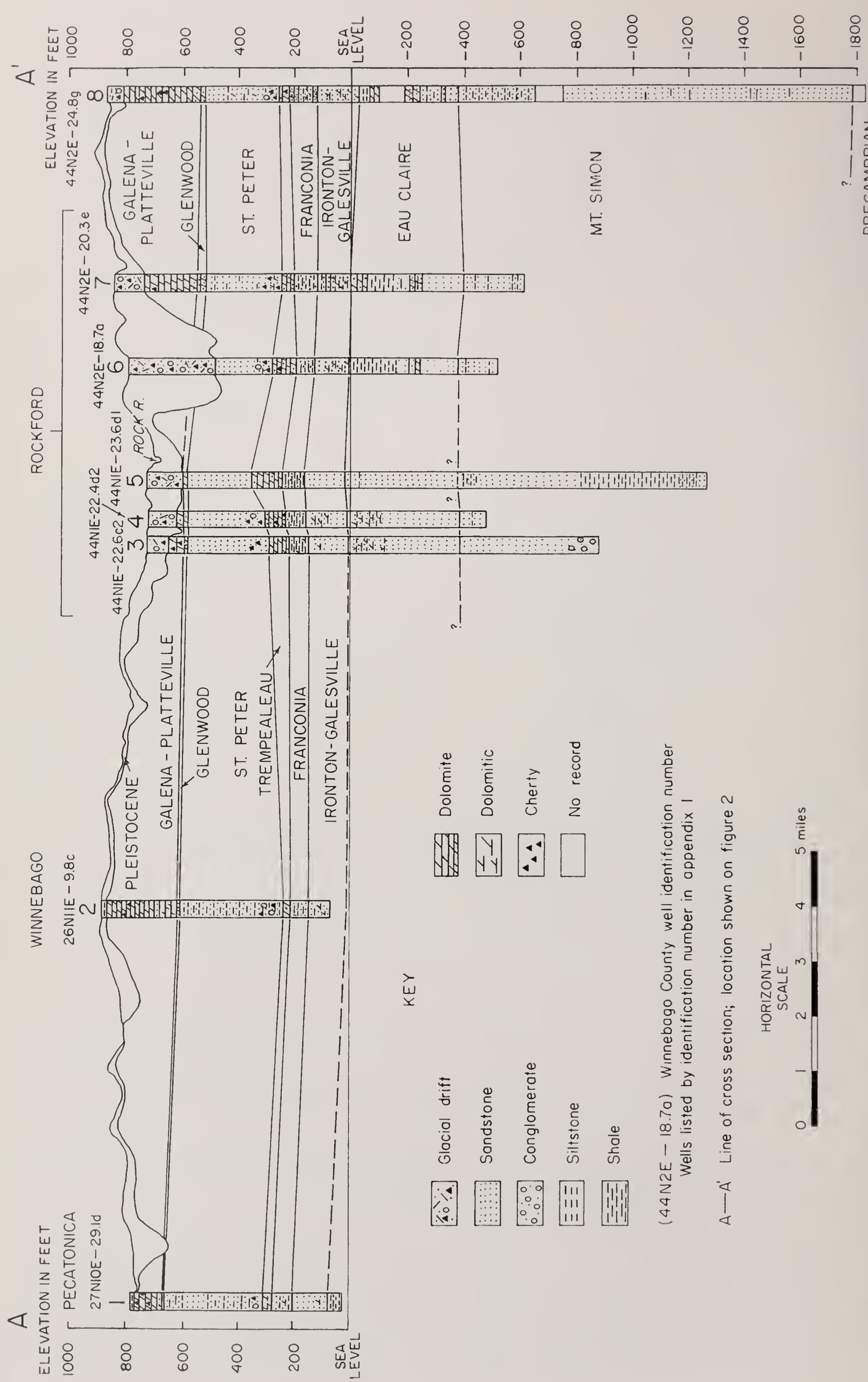


FIG. 3.—Graphic logs of some deep wells along cross section A - A' of figure 2.

Agriculture

Approximately 85 percent of the land area of Winnebago County is in farms and this agricultural economy relies heavily on the ground-water resources of the county. The U. S. Bureau of the Census (1952, p. 148) reports that in 1950 a total of 2006 farms were in operation, only six less than reported in 1945. The average size of the farms was 140 acres, but nearly 30 percent, including about 58 percent of the total farm acreage, exceeded 180 acres.

The most important type of farming in the county, both in number of farms and in value of products, is classified as "livestock farms other than dairy and poultry." In 1950, 569 farms, or about 28 percent, were reported in this group. They accounted for nearly 55 percent of the total value of the farm products sold in 1949 ($14,675,469).

Other major agricultural products are dairy products, which accounted for about 25 percent of the county's total value of farm products in 1949, and field crops, which accounted for 13.5 percent of the total value.

Climate

Winnebago County has a continental climate with warm summers and cold winters. The average temperature in July is about 73° F. and the average temperature for January is about 21° F.

The average annual precipitation of about 35 inches is distributed in northern Illinois in the following manner: 28 percent in the spring months, 32 in the summer, 26 in the fall, and the remainder (14 percent) during the winter months (U. S. Department of Agriculture, 1941, p. 851).

GEOLOGY

General Relations

Winnebago County lies within the glaciated region of northern Illinois and, during the Pleistocene Epoch, was completely overridden by glacial ice. The unconsolidated materials left by the glacial invasions are thin or locally absent on the uplands, where, for the most part, only glacial till and loess were deposited, and are thickest, generally more than 200 feet, in the major valley areas, where sand and gravel outwash was deposited by the meltwaters during several glacial advances.

A pronounced unconformity separates Pleistocene deposits from the underlying Paleozoic bedrock formations. A well developed drainage system is eroded into the bedrock surface nearly 400 feet below the gently undulatory surface of the divides (pl. 1). Throughout most of the county the uplands and valleys are directly underlain by bedrock formations of Ordovician age, but at South Beloit, at the northern edge of the county, valley entrenchment probably has penetrated the underlying Cambrian formations (fig. 10).

The Paleozoic bedrock of Ordovician and Cambrian age is composed chiefly of consolidated, stratified sediments deposited in shallow epicontinental seas that inundated this part of the continent in earlier geologic time. These sedimentary rocks rest on a basement of crystalline rocks that are Precambrian in age. The county is on the eastern flank of the Wisconsin Arch and the consolidated formations have a gentle southeastward regional dip of 15 to 25 feet to the mile. The regional structure is interrupted locally by minor shallow folds that throughout most of the county generally are parallel to the direction of the regional dip, but in the extreme southeastern part of the county the orientation is normal to the regional dip (figs. 4 and 5).

The thickness of the Ordovician and Cambrian bedrock varies throughout the county because of the uneven upper surface of the bedrock and the rise of the Precambrian crystalline basement rocks toward the Wisconsin Arch. The Ivan A. Seele et al. no. 1 oil test (WIN 44N2E-24.8g) in eastern Winnebago County penetrated nearly 2600 feet of Ordovician and Cambrian formations overlying Precambrian granite (fig. 3). The Cambrian formations, consisting principally of sandstones with thinner beds of shale and subordinate amounts of dolomite, were found to be more than 2000 feet thick. The nearly 600 feet of Ordovician formations consist of

sandstones overlain by dolomites and contain only minor quantities of shale. A summary of the formations underlying Winnebago County is given on plate 2.

Geology and Water-bearing Properties of the Bedrock Units

Precambrian rocks

Precambrian crystalline rocks have been reached by 8 wells in northern Illinois: one each in Winnebago, Boone, and DeKalb Counties, two in Lee County, and three in LaSalle County. In all these wells the Precambrian rocks were found to be gray to red, medium to coarsely crystalline granite.

The Ivan A. Seele et al. no. 1 oil test (WIN 44N2E-24.8g) penetrated the top of red granite at a depth of 2656 feet, 1786 feet below sea level. Approximately 8¼ miles southeast in sec. 28, T. 43 N., R. 3 E., Boone County, the Northern Oil and Gas Company Taylor no. 1 well penetrated the top of a gray granite at a depth of 2925 feet, 2105 feet below sea level (Grogan, 1949, table 1). Between these two wells, the elevation of the Precambrian surface drops 320 feet to the southeast, or about 39 feet to the mile. Between the well in Boone County and the Paul Schulte, Wyman no. 1 well in sec. 35, T. 41 N., R. 5 E., DeKalb County, which penetrated granite at an elevation of 2935 feet below sea level (Grogan, 1949, table 1), the Precambrian surface drops 830 feet, or about 45 feet to the mile. If a rise of about 40 feet to the mile to the northwest is assumed, the Precambrian surface at South Beloit should lie at an elevation of about 1200 feet below sea level, or between 1900 and 2000 feet below the land surface which is at an elevation of about 750 feet.

Cambrian formations

Mt. Simon Sandstone

Records are available of 26 wells in Winnebago County that are known or are assumed to enter the Mt. Simon Sandstone. Twenty-four of these are municipal and industrial wells within the city of Rockford, one is an industrial well at South Beloit, and the other is a deep oil well test east of Rockford near the eastern county line.

The Mt. Simon Sandstone is principally a poorly sorted, very fine- to very coarse-grained, white to red, silty, friable sandstone, locally conglomeratic, with thin beds of variegated shale at irregular intervals.

The basal part of the Mt. Simon is generally arkosic (Templeton, 1950, p. 154; Willman and Payne, 1942, table 1, p. 54) and in Winnebago County is overlain by several hundred feet of red, oxidized, generally silty sandstones. The red sandstone is overlain by 50 to 250 feet of pink to yellowish gray, very fine- to very coarse-grained sandstone.

The character of the Mt. Simon Sandstone is shown by the description of drill cuttings from the Ivan A. Seele et al. no. 1 test (WIN 44N2E-24.8g, appendix 2). It is the only boring in Winnebago County to penetrate the entire thickness of the Mt. Simon Sandstone, which here is 1405 feet. At the southeast corner of Winnebago County the estimated thickness of the Mt. Simon Sandstone is about 1600 feet (Templeton, 1950, fig. 1), probably the maximum thickness in the county.

The deepest water well on record in Winnebago County, Rockford city well no. 3b (WIN 44N1E-23.6d1) was drilled to a total depth of 2001 feet and probably penetrated the formation for nearly 900 feet. At Rockford the top of the Mt. Simon Sandstone is from 350 to 400 feet below sea level and available evidence indicates that the formation is approximately 1300 feet thick.

At South Beloit, the Wisconsin Power and Light Company well no. 3 (WIN 46N-2E-5.7d) penetrated 275 feet of the Mt. Simon Sandstone below a depth of 915 feet, 180 feet below sea level. The formation at South Beloit is estimated to be about 1000 feet thick, if the top of the Precambrian crystalline rocks is assumed to be about 1200 feet below sea level.

The thick red clastics forming the basal deposits of the Mt. Simon Sandstone have been explained as a facies deposited off

the mouth of a river that drained the continental area north of Illinois and discharged into the sea north of Belvidere in Boone County (Templeton, 1950, p. 158). The continental area to the north probably was an area of granitic bedrock of low relief upon which a red clayey mantle was developed under warm and humid climatic conditions. Enlargement of the sea toward the end of the time of the deposition of the Mt. Simon Sandstone brought about the deposition of the white sandstone that overlies the red sediments in Winnebago County and adjacent areas.

The zones or lenses of well sorted, fine- to coarse-grained, friable sandstone are permeable and apparently yield most of the water withdrawn from the formation. The one available log of the total thickness of the Mt. Simon shows that about 40 percent of it is composed of such sandstone, chiefly below a depth of about 1800 feet. The zones of well sorted sandstone are irregularly distributed vertically and laterally and are irregularly interbedded with silty, poorly sorted sandstone and numerous thin, shaly beds or partings of low permeability.

Eau Claire Formation

The Eau Claire Formation is penetrated by 32 wells in Winnebago County, including the 26 wells that enter the underlying Mt. Simon Sandstone. Five additional wells in the Rockford area and municipal well no. 2 in the village of Pecatonica penetrate from 44 to 300 feet of the Eau Claire Formation. In all available well records in the county the Eau Claire Formation is consistently recognized between the overlying Ironton-Galesville sediments and the underlying Mt. Simon Sandstone.

The Eau Claire Formation is principally a buff to gray, very fine- to coarse-grained, locally silty, dolomitic or argillaceous sandstone with lesser quantities of dolomitic to silty variegated shale, sandy dolomite, and siltstone. The thickness of the formation in Winnebago County, determined from well records, ranges from 358 to 445 feet and averages about 400 feet.

In Winnebago County, as in other areas in northern Illinois (Templeton, 1952; Willman and Payne, 1942, p. 54-55), three zones of the Eau Claire Formation are recognized. These zones are as follows:

Upper Zone.—Shale, dolomitic to silty, green to red with interbedded layers of siltstone, dolomite, and sandstone. Locally, the top of the formation is capped by a thin, sandy dolomite grading laterally to a silty, dolomitic sandstone. In 10 selected wells the thickness ranges from 93 to 117 feet. Average thickness is 110 feet.

Middle Zone.—Sandstone, light gray to buff-yellow, dolomitic to argillaceous and silty, very fine- to very coarse-grained, with interbedded dolomite and shale. Range in thickness in 10 selected wells is 125 to 206 feet. Average thickness is 160 feet.

Basal Zone.—Sandstone, light yellow to light gray, friable, silty to clean, very fine- to coarse-grained, generally better sorted than middle zone, with locally thin beds of light to dark gray shale or siltstone near base. Sand grains in basal beds are commonly encrusted with finely divided pyrite, giving a characteristic "sooty" appearance to the sandstone. Range in thickness in 10 wells is 100 to 180 feet. Average thickness is 130 feet.

The character of the Eau Claire Formation is shown in the sample study log of Rockford city unit well no. 3 (WIN 44N1E-2.3c, appendix 2). Here the well defined zones are about average in thickness.

The "sooty" character of the basal sands of the Eau Claire Formation indicates a peculiar depositional environment in which finely divided pyrite encrusted the sand grain surfaces. Willman and Payne (1942, p. 190, 192) suggest that conditions of water stagnation, abundance of organic matter, and bacterial action occurred intermittently during the period of clastic deposition.

Deposition of beds of sandy dolomite indicates a change in environmental conditions. Further environmental changes occurred during the late part of Eau Claire time when increasing quantities of clay, silt, and fine sand were brought into the

Eau Claire seas to produce the upper shaly zone of the formation.

The water-bearing characteristics of the Eau Claire Formation are variable because the various beds have different lithic characteristics. The beds of clean, uncemented, medium- to coarse-grained sandstone in the basal zone of the Eau Claire Formation are ground-water contributors comparable to the more permeable zones in the underlying Mt. Simon Sandstone. Many of the wells drilled to the Mt. Simon probably obtain a large part of their production from permeable zones in this basal zone of the Eau Claire. Water wells drilled into the Eau Claire Formation should be extended at least 250 feet below the top of the formation to encounter these suitable water-yielding horizons.

Some of the sandstone beds composing the middle zone of the Eau Claire Formation contain dolomitic cement and are generally less permeable than those of the basal zone. Some water may be obtained from the few thin beds of clean, better sorted, friable sandstones that locally are present in the middle dolomitic zone. The upper shaly zone is the least permeable part of the Eau Claire Formation and for practical purposes is not water-yielding.

Ironton-Galesville Sandstone

The Ironton-Galesville Sandstone in Winnebago County comprises the sandstone beds between the Franconia Formation above and the Eau Claire Formation below. These beds were first referred to the Dresbach Formation (Thwaites, 1927, table 1), and later the name "Galesville" was accepted (Willman and Payne, 1942, p. 54). It has been recognized that the upper part of the "Galesville" Formation in northern Illinois contains thin beds of sandy dolomite and thicker beds of dolomitic sandstone, whereas the lower part is nondolomitic and friable (Workman and Bell, 1948, p. 2050-57; Workman, Swann, and Atherton, 1950, p. 15). Templeton (1952) described the two parts of the "Galesville" Formation as an upper zone of buff to variegated, predominantly medium- to coarse-grained, commonly dolomitic sandstone interbedded with subordinate amounts of dolomite, and a lower zone of approximately equal thickness of mostly white, nondolomitic, principally fine- to medium-grained sandstone.

Present usage restricts the Galesville Formation in Illinois to the lower white, fine- to medium-grained, well sorted, incoherent sandstone beds that overlie the Eau Claire Formation. The overlying fine- to very coarse-grained, variegated, commonly dolomitic sandstone interbedded with thin dolomite beds has been assigned to the Ironton Formation. The top unit of the Ironton Formation is a thin, dolomitic, coarsely glauconitic, coarse-grained sandstone, formerly regarded as the basal member of the Franconia Formation (Willman and Templeton, 1951, p. 110, 113).

At some places in Winnebago County, fine- to medium-grained, well sorted, nondolomitic sandstone deposits characteristic of the Galesville Formation occur beneath the coarser textured, poorly sorted, dolomitic sandstones and thin beds of dolomite that characterize the Ironton Formation. The following part of the sample study log of a well in Rockford describes Ironton and Galesville Formations as defined above.

Rockford city unit no. 3 (WIN 44N1E-2.3c). Drilled 1948 by Varner Well Drilling Company. Total depth 1127 feet. Elevation 760 feet estimated from topographic map. Illinois State Geological Survey sample set 18072. Studied by M. P. Meyer, May 1948, and G. H. Emrich, October 1957.

	Thickness (ft)	*Depth (ft)*
Cambrian System (top at 590 feet)		
Ironton-Galesville Sandstone		
Sandstone, silty, light pinkish gray, very fine to coarse, rounded, frosted, incoherent	20	610
Dolomite, very sandy, reddish brown, very finely crystalline; some sandstone, as above	10	620
Sandstone, silty, pinkish buff, fine to coarse, rounded, frosted, incoherent, some dolomite as above	10	630
Sandstone, silty, light pinkish gray, very fine to coarse, rounded, frosted, incoherent	35	665
Sandstone, slightly silty to silty, light gray, very fine to medium, rounded, frosted, incoherent	40	705
Sandstone, slightly silty, light gray, very fine to fine, rounded, frosted, incoherent	5	710

The fine- to coarse-grained dolomitic sandstones with interbedded sandy dolomite present from the depth of 590 to 665 feet in the above log are typical Ironton lithology. The very fine- to medium-grained, nondolomitic sandstone beds below a depth of 665 feet are similar in most respects to the sandstone beds of the Galesville Formation, but in Winnebago County these sandstone beds appear to be more silty than elsewhere in northern Illinois.

At some locations in Winnebago County, the Ironton and Galesville Formations cannot be differentiated. In the following description of the drill cuttings of Rockford city well no. 5 the interval between the Franconia and Eau Claire Formations contains dolomitic beds and is more typical of the Ironton than the Galesville.

Rockford city well no. 5 (WIN 44N2E-18.7a). Drilled in 1944 by Varner Drilling Company. Total depth 1312 feet. Elevation 790 feet estimated from topographic map. Illinois State Geological Survey sample set 11440. Studied by G. H. Emrich, December 1957.

	Thickness (ft)	*Depth (ft)*
Cambrian System		
Ironton-Galesville Sandstone (top at 650 feet)		
Sandstone, silty, light grayish buff, fine to medium, some coarse, rounded, frosted, incoherent; sandstone, very dolomitic, pinkish buff to reddish brown, very fine to fine, some medium, rounded, frosted, compact	10	660
Sandstone, slightly silty, light buffish gray, medium to fine, some coarse, rounded, frosted, incoherent; some dolomite, extremely sandy, pinkish buff to reddish brown, very fine crystalline	5	665
Sandstone, silty, light grayish buff, very fine to medium, some coarse, rounded, frosted, incoherent . . .	5	670
Sandstone, slightly silty, light buffish gray, fine, some medium, rounded, frosted, incoherent.	10	680
Sandstone, silty, light grayish buff, medium to very fine, some coarse, rounded, frosted incoherent, some dolomite, slightly sandy to very sandy, pinkish buff to reddish brown, very fine	10	690
Dolomite, slightly sandy to very sandy, pinkish buff to red, very fine; sandstone, silty, light grayish buff, medium to very fine, rounded, frosted, incoherent	5	695
Sandstone, light gray, very fine to coarse, rounded, frosted, incoherent; some dolomite as above	10	705
Sandstone, silty, light gray, very fine to coarse, rounded, frosted, incoherent	10	715
Sandstone, light gray, very fine to medium, some coarse, rounded, frosted, incoherent.	5	720
Sandstone, white, fine to medium, rounded, frosted, incoherent . . .	15	735
Sandstone, slightly silty, light gray, fine, rounded, frosted, incoherent .	10	745
Sandstone, silty, light buffish gray, very fine to fine, some medium, rounded, frosted, incoherent . . .	5	750
Sandstone, silty, light buffish gray, medium to very fine, rounded, frosted, incoherent; some sandstone, very dolomitic, reddish brown to light gray, fine, some medium, rounded, frosted, compact . . .	10	760
Sandstone, silty, light pinkish-grayish buff, very fine to medium, rounded, frosted, incoherent to friable; dolomite, sandy to very sandy, pinkish buff to orange-red, very fine . . .	15	775
Sandstone, very silty, light grayish buff, very fine to fine, some medium, rounded, frosted, incoherent; some dolomite, very sandy, pinkish buff to reddish brown, very fine . . .	5	780
Sandstone, silty, light buffish gray, very fine to medium, rounded, frosted, incoherent.	5	785

Although the Galesville may be absent at this locality, it is possible that some of the lower beds are a more dolomitic facies of the Galesville Formation.

Where the Galesville Formation is recognized in Winnebago County it ranges from very thin to about 70 feet thick, and it does not exceed more than about 60 percent of the thickness of the interval between the Eau Claire Formation and the Franconia Formation.

Because of the difficulty of separating the Ironton and Galesville Formations, the interval between the Eau Claire and Franconia Formations is considered in this report to be a single unit and is referred to as the Ironton-Galesville Sandstone.

Drill-cutting samples from 25 wells in Winnebago County show that the Ironton-Galesville Sandstone is from 75 to 170 feet thick and averages about 135 feet. The elevation of the top of the Ironton-Galesville Sandstone ranges from less than 100 feet above sea level along the southern border of the county to more than 300 feet above sea level along the northern border of the county (fig. 4).

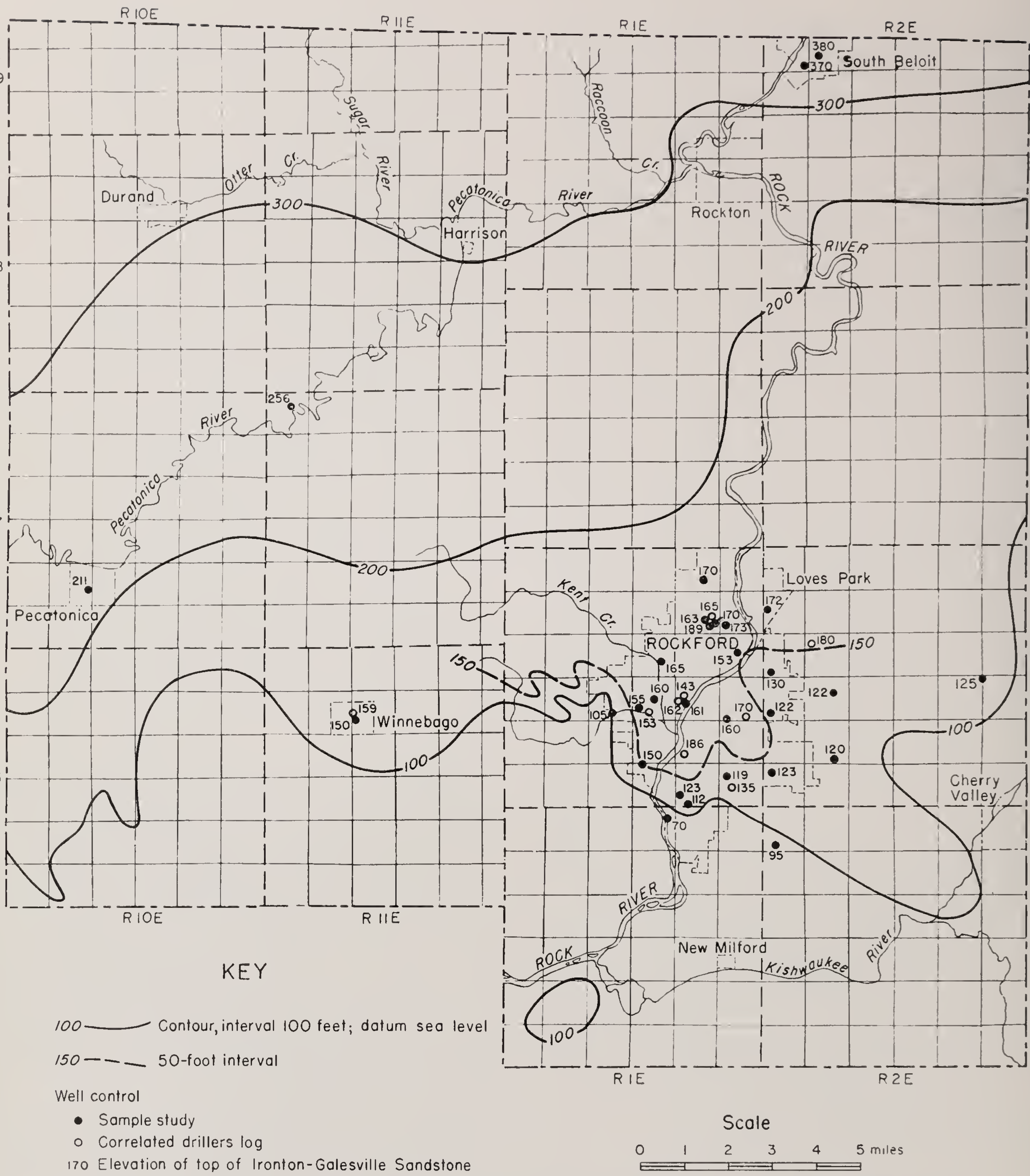


FIG. 4.—Structure of the top of the Ironton-Galesville Sandstone in Winnebago County.

Although the coarse-grained deposits of the Ironton-Galesville Sandstone rest disconformably on the underlying fine-grained Eau Claire deposits, there is no evidence of an erosional break (Willman and Payne, 1942, p. 55) and it is believed that marine conditions continued.

During the time of deposition of the Ironton-Galesville, the shallow seas often received well sorted, generally fine- to medium-grained, clastic sediments from the borderland area, resulting in the widespread deposition of permeable sands. Coarser textured, less well sorted clastic materials also were introduced into the sea and commonly were cemented by calcareous precipitates.

The permeable Ironton-Galesville Sandstone is one of the principal bedrock aquifers underlying Winnebago County. Its

permeability varies because of the irregular distribution of its various lithologies.

Franconia Formation

The Franconia Formation in Winnebago County is from 60 to 95 feet thick and consists chiefly of interbedded sandstones and shale and some dolomite. The sandstone beds generally are fine grained, mainly green to red, dolomitic, often argillaceous, glauconitic, and compact. The shale beds are mainly dark red but may be gray or green. They are sandy, silty, and glauconitic. The dolomite beds, where present, commonly are found near the top or bottom of the formation and are variegated, sandy, silty, and glauconitic. The formation is characterized by the abundance of glauconite and by lateral changes in lithology.

The general fineness of the clastics and the presence of dolomite beds indicate that during the time of deposition of the Franconia Formation the lands bordering the sea were lower or farther from northern Illinois than they were when the Ironton-Galesville Sandstone was being deposited. The nature of the sediments also indicates that the sea was shallow and the sediments occasionally were exposed on tidal flats (Templeton, 1952). Lateral variations in the strata suggest that the conditions of deposition varied and resulted in more widespread deposition of less permeable sediments throughout northern Illinois than was the case during the deposition of the Ironton-Galesville Sandstone.

The Franconia Formation has, for the most part, too much tight shale and dense fine-grained sandstone to be considered an important water-yielding unit. High-capacity municipal and industrial wells that obtain water supplies from deeper aquifers are commonly left uncased through the Franconia Formation and consequently may derive small quantities of water from crevices in the dense rocks and from the thin permeable zones in the sandstone beds.

Trempealeau Dolomite

The Trempealeau Formation consists of dolomite that is predominantly pink (in places buff or green mottled), finely crystalline, glauconitic, and at some places porous. Some chalky chert and geodes lined with drusy quartz are present. The dolomite contains variable amounts of clay, silt, and sand and generally is more sandy toward the base of the formation. Locally, thin beds of white to pink, fine-grained, dolomitic, glauconitic, compact sandstone are present at or near the base of the formation. At some places, the formation contains partings of silty, sandy, glauconitic shale.

The maximum thickness of the Trempealeau Dolomite is 100 feet in Rockford city well no. 6 (WIN 44N2E-31.7g) and the average thickness of the formation, based on 34 well records, is about 60 feet.

In north-central Illinois the average thickness is 200 feet (Willman and Payne, 1942, p. 57) and in Ogle County the average uneroded thickness of the formation is 155 feet (Templeton, 1952). In Winnebago County the formation was thinned by pre-St. Peter erosion. In the Atwood Fish Farm well no. 2 (WIN 27N11E-6.4e) the formation has been completely eroded, and the St. Peter Sandstone rests directly on shales of the Franconia Formation.

The large proportion of carbonate deposits that characterize the Trempealeau Dolomite indicate a clearing of the Cambrian seas, which previously had been laden with clastics.

Ground water is obtained from the Trempealeau Dolomite only where secondary openings such as joints, fissures, and solution channels have developed. The distribution and size of such openings is not known but their presence has been reported by drillers. No wells are known to obtain water supplies solely from the Trempealeau Dolomite in Winnebago County, but it probably in some instances contributes water to large-capacity wells drilled to the deeper sandstone aquifers.

ORDOVICIAN FORMATIONS

St. Peter Sandstone

The St. Peter Sandstone underlies all of Winnebago County except at South Beloit where the deep channel of the Rock Valley may cut through it (fig. 10). Along

the Rock, Pecatonica, Sugar, and Troy Valleys it directly underlies the glacial drift and its original thickness has been reduced by erosion. Where it is overlain by younger Ordovician strata, its thickness ranges from 200 to 360 feet, as is shown by sample cuttings of 19 wells. This range in thickness results chiefly from deposition on an uneven surface. The average thickness of the St. Peter Sandstone in the county is about 265 feet.

The St. Peter Sandstone is, for the most part, fine- to coarse-grained, friable, locally silty and argillaceous, and is characterized by a high percentage of quartz grains that are generally well rounded and frosted. Several of the beds contain coarse-grained sand. The sandstone in the upper part of the formation is principally white but ranges to buff. In the lower part it is principally pink or red. The red color is caused by iron oxide, which occurs as intergranular cement or as film on the grains.

In Winnebago County, the St. Peter Sandstone commonly contains a cherty basal zone of compact to quartzitic sandstone interbedded with conglomerate, siltstone, and clay or shale. The chert generally is white to buff, often oolitic, and locally forms beds. The clays and shales are brownish red to maroon but locally are variegated, are generally silty or sandy, and are often cherty. The clays and shales in the basal zone of the St. Peter Sandstone frequently cave into the well bore. In some instances the caving is so troublesome in well construction that installation of casing liners is required.

The basal zone ranges from a few feet to more than 70 feet thick and is characterized by rapid lateral changes in lithology and thickness.

The summary of the sample study of drill cuttings from Rockford city well no. 6 WIN 44N2E-31.7g (appendix 2) illustrates the character of the St. Peter Sandstone. In this well the formation is 235 feet thick and the basal zone is about 40 feet thick.

The advancing St. Peter sea moved over an uneven erosional surface upon which a thick mantle of dark reddish brown, cherty, residual clay had been left as a weathering product (Templeton, 1952). This residual clay, along with coarser textured stream-transported material and debris eroded from the underlying bedrock, was reworked and deposited by the advancing sea to form the cherty conglomerate and soft shales at the base of the St. Peter Sandstone.

Large quantities of well sorted, well rounded, quartz sand were introduced into the St. Peter sea. The frosting and pitting of the sand grains that characterize the St. Peter Sandstone may indicate that the grains had been much worn by wind before deposition in the sea. Relatively stable conditions resulted in a deposit having generally uniform water-yielding characteristics over wide areas.

The St. Peter Sandstone is widely utilized as an aquifer in Winnebago County. Approximately 71 wells on record obtain water supplies either principally or entirely from it. The water-yielding character of the St. Peter Sandstone depends upon the thickness of the formation, the amount of fine sediment (clay, silt, and very fine-grained sand) in the incoherent beds, and the character and thickness of the less permeable basal zone.

Large-capacity wells drilled to deeper bedrock aquifers are commonly open in the St. Peter Sandstone and it contributes to the total water production of these wells.

Glenwood Formation

The Glenwood Formation has been recognized in a large number of wells in Winnebago County and appears to underlie most of the county except where St. Peter and older formations constitute the bedrock surface. The thickness of the formation ranges from generally less than 10 feet in western and northwestern Winnebago County to possibly 60 feet in the southeastern corner of the county. In the Camp Rotary well (WIN 43N2E-28.4f), about 3 miles east of New Milford, 51 feet

of sandstone and dolomite assigned to the Glenwood Formation was penetrated.

The Glenwood Formation consists of interbedded dolomite, sandstone, and shale. The dolomite beds are light gray, buff, or green, lithographic to finely crystalline, argillaceous, silty or sandy. The sandstone beds are chiefly gray-green, buff, or white, but locally brown to yellow; they are silty, argillaceous, and often dolomitic and glauconitic. The quartz sand grains range in size from fine to coarse, and are well rounded and frosted. The shales generally are gray-green to bluish green, partly silty or sandy, and range from plastic to tough. In Winnebago County the shales generally occur as thin partings in the thicker beds of sandstone and dolomite but in the upper part of the formation they may occur as distinct beds 5 feet or more thick. The formation is characterized by rapid lateral variation in lithology so that correlation of individual units from one well to another is uncertain.

The basal beds of the Glenwood Formation generally are more sandy than the upper beds, which tend to be predominantly dolomites and shales. As the sandstone at the base of the Glenwood is similar to that of the underlying St. Peter, it is generally not possible to distinguish the two formations in drillers logs. A slight erosional unconformity is reported to separate the Glenwood and St. Peter Formations in northern Illinois (Bevan, 1926, p. 11-13; Willman and Payne, 1942, p. 63).

The sea, which readvanced during Glenwood time, reworked the upper part of the St. Peter sand depositing and intermixing finer textured materials that were derived from the continental area. At times the Glenwood seas were turbid, and relatively sand-free shales were deposited locally. In the latter part of Glenwood time the seas became clearer, and calcareous sediments with various proportions of clastics were deposited.

The lateral variations in lithology over short distances and erosion and channeling within the sediments are evidence that the Glenwood Formation was deposited in shallow, agitated water (Templeton, 1952). The permeability of the resulting deposits varies but generally is low.

The shales and dolomites of the Glenwood Formation are of little value as an aquifer in Winnebago County. Locally, however, the basal sandstone beds of the formation probably provide some water to wells drilled into the underlying St. Peter Sandstone or deeper formations.

Galena, Decorah, and Platteville Formations

The upper bedrock formations in most of the county (fig. 10) are dolomites of the Galena, Decorah, and Platteville Formations. Because these formations cannot be distinguished from each other in drillers logs and because their water-yielding characteristics are similar, they are here discussed together.

The combined thickness of the three formations varies because the bedrock surface has been eroded. The largest combined thickness of the dolomite formations penetrated by wells in Winnebago County is 276 feet in Rockford city well no. 10 (WIN 44N2E-29.3a). Maximum thickness of the dolomites as estimated by comparison of the elevation of the base of the Platteville Dolomite (fig. 5) with the elevation of the bedrock surface (pl. 1) is about 340 to 350 feet in the vicinity of sec. 1, T. 44 N., R. 2 E.

The sample study log of the Ivan A. Seele et al. no. 1 oil test (appendix 2) shows the lithic characteristics of the Galena, Decorah, and Platteville Formations in Winnebago County.

The Platteville Dolomite, which overlies the Glenwood Formation, is composed of light gray, yellowish gray, or brown dolomite, generally finely crystalline, dense to finely porous, partially argillaceous, and has shaly partings. The upper part of the formation is commonly cherty and the lower part is sandy, locally grading to fine- to coarse-grained dolomitic sandstone at the base. In Winnebago County the uneroded thickness of the Platteville Dolomite ranges from 94 feet to 137 feet and the average thickness of the formation based on records of 11 wells is about 112 feet.

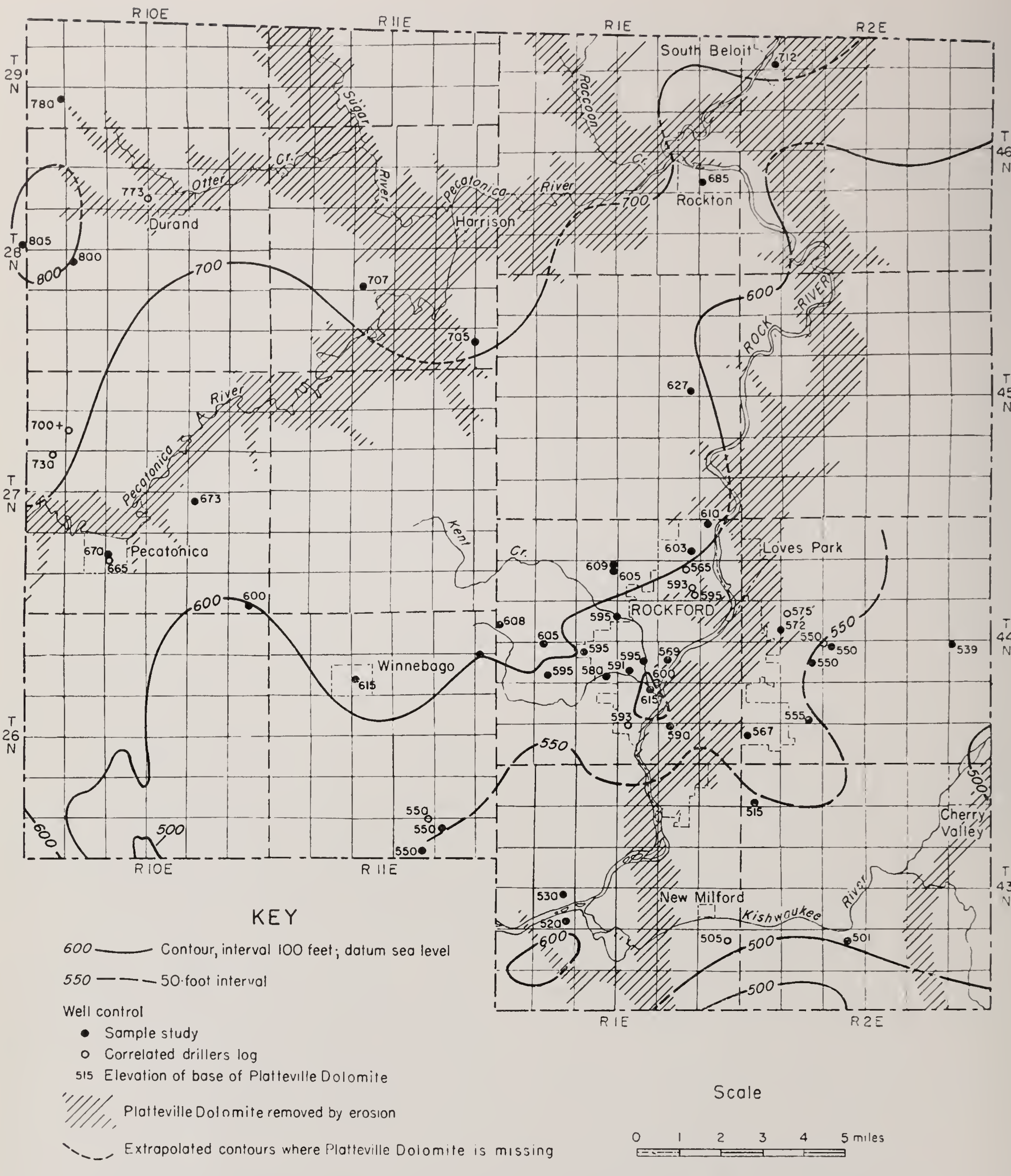


Fig. 5.—Structure of the base of the Platteville Dolomite in Winnebago County.

The Decorah Formation, which overlies the Platteville Dolomite and underlies the Galena Dolomite, has been recognized in study of sample cuttings of several wells in Winnebago County. The formation consists of light gray to buff, silty, very fine- to medium-grained, gray to red speckled, slightly cherty dolomite with green or brown shale partings. The uneroded thickness of the Decorah Formation, where it has been recognized in sample studies, ranges from 3 to 32 feet and the average thickness is about 21 feet.

The Galena Dolomite is a yellowish gray to buff or brown, mostly medium- to coarse-grained, partly cherty, often porous dolomite. The chert may be distributed throughout the formation but is generally

concentrated in the basal beds. As previously mentioned, the original thickness of the Galena Dolomite has been reduced by erosion.

During the time the Platteville, Decorah, and Galena Formations were being deposited, the seas became clear and the sediments were principally calcareous. Occasional contributions of clastic materials formed shale partings and sandy dolomite beds, especially in the Decorah. It was a time of stability when marine life flourished, as evidenced by the fossils preserved in the formations.

The Galena, Decorah, and Platteville Formations yield ground water through joints, bedding planes, fractures, solution channels, or other openings secondarily produced in the dolomite. Although the water-yielding capacity of wells into the formations can be expected to vary with the size, number, and degree of interconnection of the openings, the dolomites of the Galena, Decorah, and Platteville Formations are recognized by water well drillers as a consistent and dependable source of ground water.

STRUCTURAL HISTORY

The bedrock formations of Paleozoic age that underlie Winnebago County contain a record of frequent invasions by shallow continental seas into which sediments were contributed by erosion of adjacent land masses. Local and widespread tectonic activities disturbed the attitude of the sedimentary rocks and the periods of deposition were separated by periods of erosion as the land area rose in relation to sea level. During exposure, the sediments underwent weathering, erosion, and, under suitable hydrologic conditions, extensive flushing by fresh meteoric water.

A major period of structural disturbance culminated at the end of Prairie du Chien time in the early part of the Ordovician Period with a structural uplift in northeastern Illinois that formed the Kankakee Arch. This monoclinal arch was raised 500 to 600 feet above the region to the southwest (Ekblaw, 1938, p. 1428). The erosion subsequent to the uplift removed the dolomites and sands of the Prairie du Chien Series, along with much of the upper part of the Trempealeau Dolomite, from the formational sequence in Winnebago County. The eroded surface, upon which the St. Peter Sandstone was deposited, forms a marked unconformity within the Paleozoic bedrock.

There is no evidence of the depositional history of the Paleozoic Era in Winnebago County following the deposition of the Platteville, Decorah, and Galena Formations. From evidence in the surrounding area it can be concluded that the area was inundated at least in the Silurian Period and possibly during the Devonian, Mississippian, and Pennsylvanian Periods (Templeton, 1952). Near the end of the Mississippian Period, northern Illinois was subjected to major structural disturbances (Willman and Payne, 1942, p. 195), during which time most of the structural features shown in figures 4 and 5 were imposed upon the Paleozoic strata. The features consist primarily of gentle folds that exert little influence on ground-water occurrence or movement.

By the end of Pennsylvanian time, at least, marine water withdrew for the last time and for the remainder of geologic time the area was exposed to subaerial weathering and erosion. During this time, the deposits were thoroughly flushed of the saline marine waters they must have contained during the time of marine inundations. The flushing has been so complete that potable waters are now obtained to depths of at least 2000 feet.

Topography and Erosional History of the Bedrock Surface

During the long period between the final retreat of the shallow continental seas from the upper Mississippi Valley and the advance of the continental glaciers, stream erosion reduced and dissected the surface of the exposed rock. By late Tertiary or early Pleistocene time the major topographic features of the bedrock surface were developed. This surface of erosion that is preserved on bedrock of Paleozoic age and is now largely buried by glacial de-

posits has a maximum relief of about 500 feet (pl. 1), or about 200 feet greater than the maximum relief of the present surface. During the erosional development of this ancient land surface some of the principal features controlling the occurrence of water-yielding deposits in Winnebago County were evolved.

The bedrock topography of the upper Mississippi Valley has been studied for more than 60 years and described either as the result of differential erosion (Martin, 1932, p. 16) or of one or more periods of peneplanation interrupted by a lowering of base level with a subsequent rejuvenation of erosion (Hershey, 1896, p. 75-88; Trowbridge, 1921, p. 60-127, 799-804; Bates, 1939, p. 725-841; Horberg, 1946, p. 87-99). Although the concept of multiple erosion cycles has been favored by the majority of the students of the problem, the number of erosion cycles involved and the time of their development remains uncertain.

Throughout most of Winnebago County, especially in the upland areas, the deposits of glacial drift that overlie this surface are thin (fig. 8) and at many places the bedrock is exposed. These outcrops are important control points in drawing the configuration of the bedrock surface. In the major valley areas the thickness of the glacial deposits is much greater, bedrock outcrops are generally absent, and control points on the bedrock surface can be obtained only from well records. Where the bedrock surface is deeply buried and where well information is sparse, interpretations must be considered approximate and subject to change when additional data are obtained.

As shown on plate 1, the bedrock surface consists of four principal upland areas deeply dissected by three major ancient valleys—the Rock, Pecatonica-Sugar, and Troy Valleys.* Locally, the surface of the bedrock has been modified by drainage changes or diversions which, like the narrow, gorge-like valleys of the Rock and Kishwaukee Rivers in the southern part of the county, are clearly the result of glacial invasions and will be discussed with glacial features in the following section.

*In this report the terms Pecatonica Valley, Rock Valley, etc., refer to the older valleys eroded prior to glaciation of the region. The terms Pecatonica River Valley, Rock River Valley, etc., refer to the present land surface valleys in which there are streams or rivers.

UPLAND AREAS

Much of the bedrock upland is dissected slopes between the higher elevations of the bedrock surface and the deeply incised bedrock valleys. The higher elevations on the upland include broad, gently rolling, relatively undissected areas. This higher upland surface is best displayed in central and southwestern Winnebago County between the Rock and Pecatonica Valleys where the elevation ranges from 800 to slightly more than 900 feet.

The altitude of the upland surface decreases gradually from the northwestern corner of the county, where its elevation is about 900 to about 950 feet, to near the southeastern corner of the county, where the elevation is about 800 to slightly less than 850 feet. There appears to be a slight depression in this surface in the north-central part of the county between the Rock and Pecatonica-Sugar Valleys where the average elevation of the higher level upland surface is nearly 50 feet lower than the average elevation to the east, northwest, west, or southwest.

VALLEY AREAS

The deeply cut valleys in the bedrock surface are characterized by sharp slopes and narrow, deeply incised tributaries. For the most part, they have been nearly filled by glacial drift and alluvium so that on the present surface only broad alluviated lowlands indicate their position (fig. 2). Although the location and general course of the valleys are evident, the details of the surface buried beneath the broad valley areas is known only from logs of water wells and test borings.

The principal bedrock valley, the Rock, enters the county at South Beloit and continues southward, passing under the eastern part of Rockford, to leave the county at the southwestern edge of T. 43 N., R. 1 E.

The Pecatonica Valley enters Winnebago County from the west near Pecatonica and underlies the large lowland now occupied by the Pecatonica River. Northeast of Pecatonica the valley trends northeastward to Harrison where it is joined by the Sugar Valley from the north. The Pecatonica-Sugar Valley continues eastward from Harrison about 4 miles, then swings northward to loop around the northern edge of Rockton, and joins the Rock Valley about one mile east of that community.

The Troy Valley cuts across the extreme southeastern corner of Winnebago County. It enters the county at the town of Cherry Valley, underlies the wide lowland now occupied by the Kishwaukee River and the South Branch, and leaves Winnebago County near the southeastern corner.

Bedrock Channels

As shown on the bedrock surface map (pl. 1) and the geologic cross sections (figs. 3 and 7), these valleys in the bedrock surface are entrenched 300 to 350 feet below the upper level of the adjoining upland surfaces. The lowest bedrock surface elevations established by well logs are in the southern part of Rockford where wells WIN 44N1E-35.5a and WIN 44N1E-35.6a penetrate the St. Peter Sandstone at elevations of 440 and 441 feet, respectively. Other well data in the area indicate that these wells probably are in or near the thalweg of the ancient valley.

A test hole drilled for the city of Rockford (WIN 44N1E-26.1d) penetrated 267 feet of glacial drift to an elevation of about 453 feet without entering bedrock. Approximately 3 miles north, the Bradley Heights subdivision well (WIN 44N2E-18.4h) penetrated 340 feet of glacial drift and entered the St. Peter Sandstone at an elevation of 460 feet. However, it is unlikely that this represents the lowest elevation of the bedrock channel in that part of the valley.

South of Rockford the elevation of the deepest part of the valley is unknown, owing to a lack of well data, but it is likely to be somewhat lower than that at the Rockford Screw Products Company wells because of the southward gradient of the ancient valley.

North of the Rockford–Loves Park area, only scattered data indicating the elevation of the bedrock surface are available. At South Beloit the Wisconsin Power and Light Company well no. 3 (WIN 46N2E-5.7d) penetrates the bedrock surface at an elevation of 510 feet. It is believed that this well does not penetrate the deepest part of the bedrock channel, for to the north in Beloit, Wisconsin, and therefore upgradient, a well at Fairbanks, Morse and Company enters bedrock at an elevation of about 509 feet.

A well (WIN 46N1E-13.4c) near Rockton enters the St. Peter Sandstone at an elevation of 545 feet beneath 205 feet of valley fill consisting chiefly of fine sand. This well is probably in the Pecatonica–Sugar Valley but is not in the deepest part of the channel. West of this well, between Rockton and Pecatonica, three other wells (WIN 28N11E-27.1a, WIN 27N11E-6.4e, and WIN 27 N11E-6.1e) are drilled through thick valley fill deposits and penetrate the St. Peter Sandstone at elevations of 545, 550, and 584 feet, respectively, indicating a deep channel in the bedrock beneath the floodplain of the Pecatonica River.

No well data are available in Winnebago County on the deep channel mapped in Wisconsin by Alden (1918, pl. II) and in Illinois by Horberg (1950, pl. 1) along the Sugar River Valley. However, a single well record (WIN 28N10E-10.5b) at Durand shows a bedrock surface elevation of 590 feet that indicates a deep channel that is probably tributary to a deeply cut bedrock valley beneath the alluvial fill of the Sugar River Valley.

No record is available of wells penetrating bedrock in the thalweg of Troy Valley in Winnebago County. One well (WIN 43N2E-22.1d2), drilled 265 feet through "drift, gravel and quicksand" but not entering bedrock, indicates that the elevation of the bedrock surface is less than 530 feet. Well data along the Troy Valley in Boone County to the northeast and DeKalb County to the southeast indicate that the valley contains a deep, narrow channel, the floor

of which is probably below an elevation of 450 feet in Winnebago County.

Evidence of the configuration of the buried parts of the bedrock valleys is largely restricted to the Rockford–Loves Park area where many large capacity wells have been drilled. Here, the available well data indicate that the floodplain of the ancient valley was relatively narrow and fairly consistent in width. As outlined by the 50-foot contour interval on plate 1, the width of the bedrock valley floor does not exceed one-half to three-fourths of a mile and has many narrow, sharp-sloped tributary valleys. The configuration north and south of Rockford and Loves Park is assumed to be similar, although the valley floor may widen slightly to the north. The contact between the Platteville and the Glenwood or St. Peter Formations rises to the north, and larger parts of the bedrock valley are underlain by sandstones and shales that are less resistant to erosion than dolomite. The relatively narrow floodplain of the deeply incised channel and the sharp-sloped, gorge-like character of its tributary valleys are indicative of a drainage system in the youthful stage of valley erosion.

Benches or Straths

As shown on plate 1, several well records near Rockford, Loves Park, and South Beloit indicate that the deep, narrow bedrock channel is bounded by slopes notably steeper than the slopes of the exposed valley walls. Other data suggest the presence of relatively level rock benches or straths beneath the level of the valley fill between the exposed valley wall and the deep-cut channel. For example, along the northern border of Winnebago County west of South Beloit, in the widest part of the Rock River Valley but west of the deep-cut channel, a group of wells in sec. 6, T. 46 N., R. 2 E., and secs. 1 and 2, T. 46 N., R. 1 E., penetrate a relatively level bench on dolomite bedrock at an elevation of from 740 to 755 feet (fig. 6, pl. 1). In none of these wells does the thickness of the unconsolidated deposits exceed 30 feet.

In South Beloit, east of the Rock River, the Chicago, Milwaukee, St. Paul & Pacific Railroad well (WIN 46N2E-6.2b) enters the Platteville Dolomite at an elevation of about 725 feet. Approximately one-half mile northeast, the Wisconsin Power and Light Company well no. 3 (WIN 46N2E-5.7d) enters the St. Peter Sandstone at an elevation of 510 feet, having penetrated 225 feet of valley fill. This record establishes the position of a deeply buried channel and, along with the Chicago, Milwaukee, St. Paul & Pacific Railroad well, demonstrates the steepness of the buried valley slopes, which drop away from the level subfill strath or bench more than 200 feet in half a mile.

Two wells (WIN 46N2E-7.2g and WIN 46N2E-7.6c) east of the Rock River and South Beloit penetrate this strath, floored by the Platteville Dolomite, at elevations of 720 and 735 feet. Therefore, at South Beloit the Rock River flows across a thinly covered, relatively level bedrock strath or bench ranging in elevation from about 720 to about 760 feet. This strath or bench extends at least as far southwest as the NW¼ sec. 15, T. 46 N., R. 1 E., northwest of Rockton, where the Platteville Dolomite is exposed in a quarry. It probably extends westward to the valley of Raccoon Creek. West of Raccoon Creek Valley the bedrock surface rises to the upland surface, which has an elevation of more than 900 feet (fig. 6).

East of the buried channel of the Rock Valley at South Beloit is another extensive lowland area beneath which a bedrock bench may occur at a level similar in elevation to the broad, relatively flat surface west of the deeply cut channel. Two wells (WIN 46N2E-3.2a and WIN 46N2E-10.2h) in the broad valley between three-fourths and one mile west of the present eastern valley wall enter dolomite at an elevation of 725 feet. Lack of suitably located subsurface data west of these control points prevents the definite determination of a bedrock bench or strath.

At other points along the Rock Valley, well records show the bedrock surface at relatively shallow depths beneath the valley fill and support the interpretation that bedrock benches or straths occur beneath

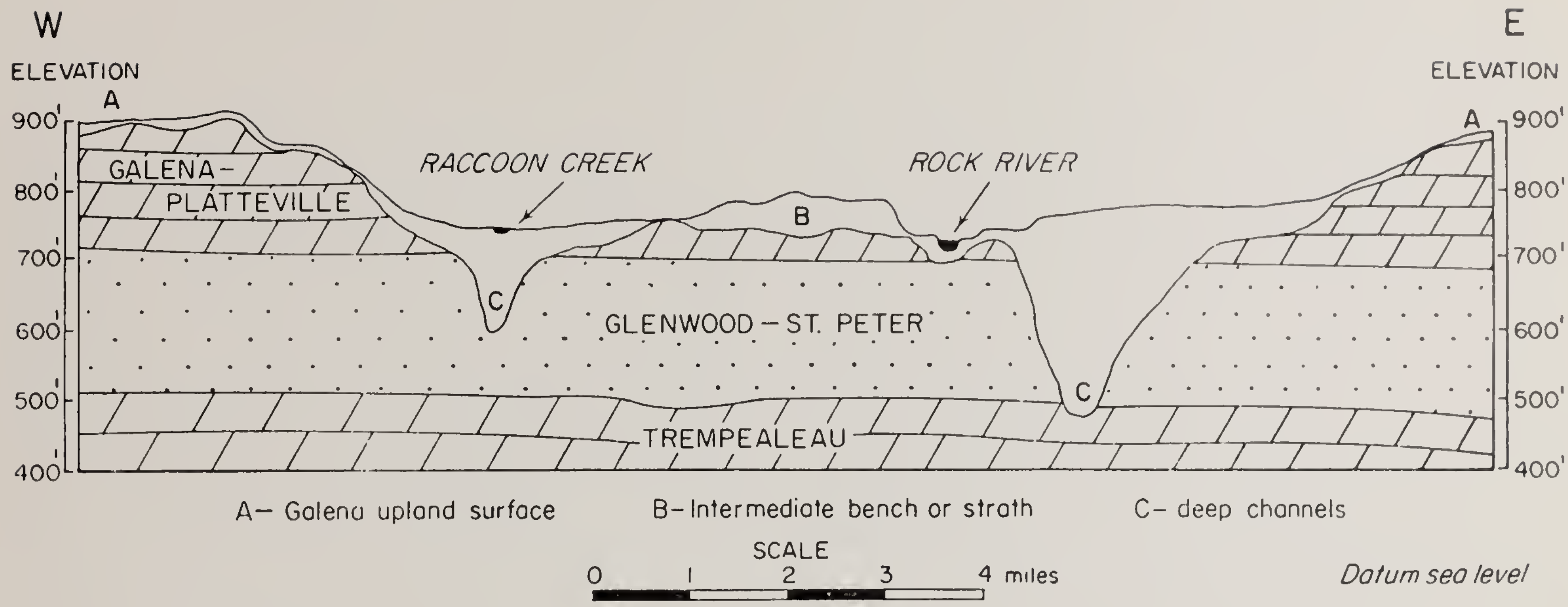


FIG. 6.—Diagrammatic cross section showing relations of erosional surfaces as interpreted from well records and bedrock outcrops near South Beloit.

the valley fill. They also show that the deeper points on the bedrock surface lie within a narrow, steep-sloped channel incised 150 to 250 feet below the benches. Considerable additional subsurface data are needed before the location, extent, and number of these buried benches can be established throughout the Rock Valley and the associated bedrock valleys.

An erosional surface in northwestern Illinois at position intermediate to the undissected upland surface and the deeply cut part of the valleys has been noted in earlier reports. Hershey (1896, p. 84) described a rock shelf in the Pecatonica Valley buried 20 feet under the river level at Freeport. He assumed that it is not an isolated phenomenon and that such shelves probably were to be found at other locations throughout and far beyond the district.

In northeastern Ogle County in the vicinity of Lindenwood, about 6½ miles south of the Winnebago-Ogle county line, Bretz (1923, p. 276, 277) described "a broad and fairly plane rock surface" at an elevation of 700 to 750 feet and adjacent to the deeply buried channel of the Rock Valley. Bretz suggested this as evidence that there are two partially completed erosion cycles in the Rock Valley.

Although Horberg (1950, p. 94) recognized the possibility of an erosional surface 100 to 180 feet below the bedrock uplands in Stephenson, Winnebago, and Ogle Counties, he did not believe it extensive enough to be described as a regional feature on a 50-foot contour interval map of the bedrock surface. Horberg patterned the width of the buried channels on the width of the exposed part of the partially filled valleys and thereby eliminated the possibility of expression of an intermediate buried erosional surface. As shown on plate 1, however, intermediate erosional levels can be delineated by a 50-foot contour interval because the bedrock channels are interpreted as being narrow in relation to the width of the present valleys.

EROSIONAL HISTORY

The evidence presented above indicates that at least three erosional levels were formed prior to continental glaciation in Winnebago County. The oldest of these is represented by the areas of upland preserved along the major drainage divides in the county (A in fig. 6). The elevation of this upland ranges from about 800 feet in the southeastern part of the county to about 950 feet in the extreme northwestern part of the county. This is the Galena upland surface defined by Horberg (1946, p. 183) which is extensively developed throughout northwestern Illinois and which he correlates with the Lancaster or late Tertiary peneplain.

A second level (B in fig. 6), 100 to 180 feet below the upland, occurs beneath the valley fill within the principal bedrock valleys. This bench or strath is well developed on the Platteville Dolomite at elevations of 720 to 760 feet above sea level. Also bordering the report area, fairly level rock shelves occur in a more or less similar position at Freeport in the Pecatonica Valley and near Lindenwood in northeastern Ogle County along the buried Rock Valley. The bench or strath was cut into the late Tertiary Lancaster surface and predates the erosion of the deep channels.

In central and northeastern Illinois, Horberg (1946, p. 186-190) describes two erosional surfaces, the Central Illinois peneplain and the Havana strath, postdating the Lancaster surface and predating the deeply entrenched channels. The intermediate bench or strath in the major valleys of Winnebago County and adjoining areas may be a northward expression of the Central Illinois peneplain rather than of the Havana strath. Additional work in locating and tracing this surface along the major bedrock valleys is necessary before the correct age relationships can be established definitely, but it appears to be of late Tertiary age.

The deep valleys, entrenched 200 to 260 feet below the intermediate surface, have steep-sloped walls and narrow floors. The erosional development of these valleys had reached only a youthful stage when the valleys were partly or completely buried by glacial activity.

No evidence is available in Winnebago County to prove the age of the deep valleys. They were cut before Farmdale glaciation and after the development of the Central Illinois peneplain. Horberg (1950, p. 98) concluded that the channels were eroded during the late part of the Pliocene and the early part of the Pleistocene, whereas Trowbridge (1921, 1954) considers the deep channel of the upper Mississippi River, possibly a comparable land form, to be no older than the Nebraskan glacial stage.

Geology and Water-Bearing Properties of the Glacial Deposits

General Relations

Intensive study of the glacial deposits and their related features in the upper Mississippi Valley area has resulted in recognition of four major stages of continental glaciation separated by long interglacial intervals. The classification of the Pleistocene deposits for Illinois is as follows:*

Stage	*Substage*
Recent	
Wisconsin Glacial	Mankato Cary Tazewell Iowan Farmdale
Sangamon Interglacial	
Illinoian Glacial	Buffalo Hart Jacksonville Payson Loveland
Yarmouth Interglacial	
Kansan Glacial	
Aftonian Interglacial	
Nebraskan Glacial	

During the Pleistocene Epoch, continental glaciers advanced from centers of accumulation in central and eastern Canada and invaded the upper Mississippi drainage basin as far south as southern Illinois. These glacial invasions are recorded by unconsolidated rock debris, or drift, that was dumped on the land surface either directly from the ice as it melted or from its sediment-laden meltwater, and by extensive drainage diversions that resulted from ice or drift in the valleys.

The materials deposited by the ice as it wasted from the region formed an irregular blanket of unsorted, unstratified glacial till in the valleys and on the uplands. Meltwater heavily loaded with rock debris issued from the ice fronts into the adjacent valleys

*Since this report was prepared, the substages of the Wisconsin glacial stage have been reclassified in Illinois Geol. Survey Circ. 285. The glacial deposits here called Farmdale have been renamed Winnebago and are assigned to the Altonian substage (older than the Farmdalian substage), and the Shelbyville and younger moraines have been assigned to the Woodfordian substage (younger than Farmdalian).

and lowlands and partly filled them with sorted, stratified deposits of sand and gravel outwash. Where meltwater was ponded, fine sand, silt, and clay were deposited. Winds whipping over river flats that were kept free of vegetation by the frequent floods of glacial meltwater picked up and transported large volumes of silt and deposited it as loess on the adjacent uplands. In this manner, depositional and erosional processes associated with continental glaciation extensively altered the land surface that had been produced by the long period of erosion preceding the glacial epoch.

The glacial deposits that mantle the upland areas of most of Winnebago County have been assigned for many years to the Illinoian glacial stage. Only a small area in the southern part of the county was believed to have been covered by ice during the Wisconsin glaciation. Recently the deposits called Illinoian have been interpreted as early Wisconsin in age and assigned to the Farmdale interval of glaciation (Shaffer, 1956, p. 10).

During Farmdale time, all of Winnebago County was covered by glacial ice. After the Farmdale ice melted a short period of weathering took place. Loess was then deposited before the advance of the Shelbyville ice in early Tazewell time (Shaffer, 1956, p. 15).

The Shelbyville ice invaded only the very southern part of Winnebago County, advancing to a position now marked approximately by the Kishwaukee River and the narrow rock-walled valley of the Rock River (Leighton, 1923, fig. 1; Bretz, 1923, pl. IV). The subsequent advance of the Tazewell ice did not enter Winnebago County but advanced to within about 7 miles of the southeast corner of the county where it built the prominent Bloomington moraine (Leverett, 1899, pl. VI, p. 246-248). Outwash from the ice front was carried into Winnebago County via the valleys of Killbuck Creek and the Kishwaukee River and its south branch. Later advances of the Tazewell ice were even farther removed from Winnebago County.

During Cary time, ice of the Green Bay lobe advanced to near Janesville, Wisconsin, about 15 miles north of the Winnebago county line, where it built a prominent moraine and disgorged outwash sands and gravels into Winnebago County along the Rock River Valley (Alden, 1918, p. 209-211, pls. III, XXIII). Following the melting of this Cary ice (Thwaites, 1950, pl. III) from its forward position at Janesville, the depositional features of the glacial history of Winnebago County were essentially completed. During the remainder of the Pleistocene, the erosion of the prominent terraces along the Rock River Valley and the establishment of the present course of the Rock River and its tributaries were the chief developments.

Thickness of glacial drift is shown on figure 8.

PRE-FARMDALE DEPOSITS

A basal sand in the deep channel of the Rock Valley is probably the oldest unconsolidated deposit overlying bedrock in Winnebago County. This sand has been recognized in four wells in the Rockford area where it lies on the bedrock and is separated by a weathered zone from the overlying glacial outwash, here interpreted as Farmdale in age. Well records indicate that this basal sand does not now occur as a continuous fill in the ancient valley and it apparently is confined to the deepest part of the valley (fig. 7).

The basal sand deposit and the associated weathered zone is well displayed in the lowest cuttings from Rockford city well no. 14 (WIN 44N1E-35.7a, appendix 2).

The sediments below the weathered zone in the basal part of Rockford city well no. 14 consist of material no coarser than fine sand, but in the well (WIN 44N1E-35.7b) of the Northwest Malleable Iron Corporation and the no. 2 well (WIN 44N1E-35.5a) at plant no. 2 of the Rockford Screw Products Company, the clastics below a leached and oxidized zone near the base of the valley fill are coarse sand and gravel with pebbles up to half an inch in diameter. The grains and pebbles are principally quartz and chert, but some are igneous.

The relationships and stratigraphic position of the basal sand at Rockford establish

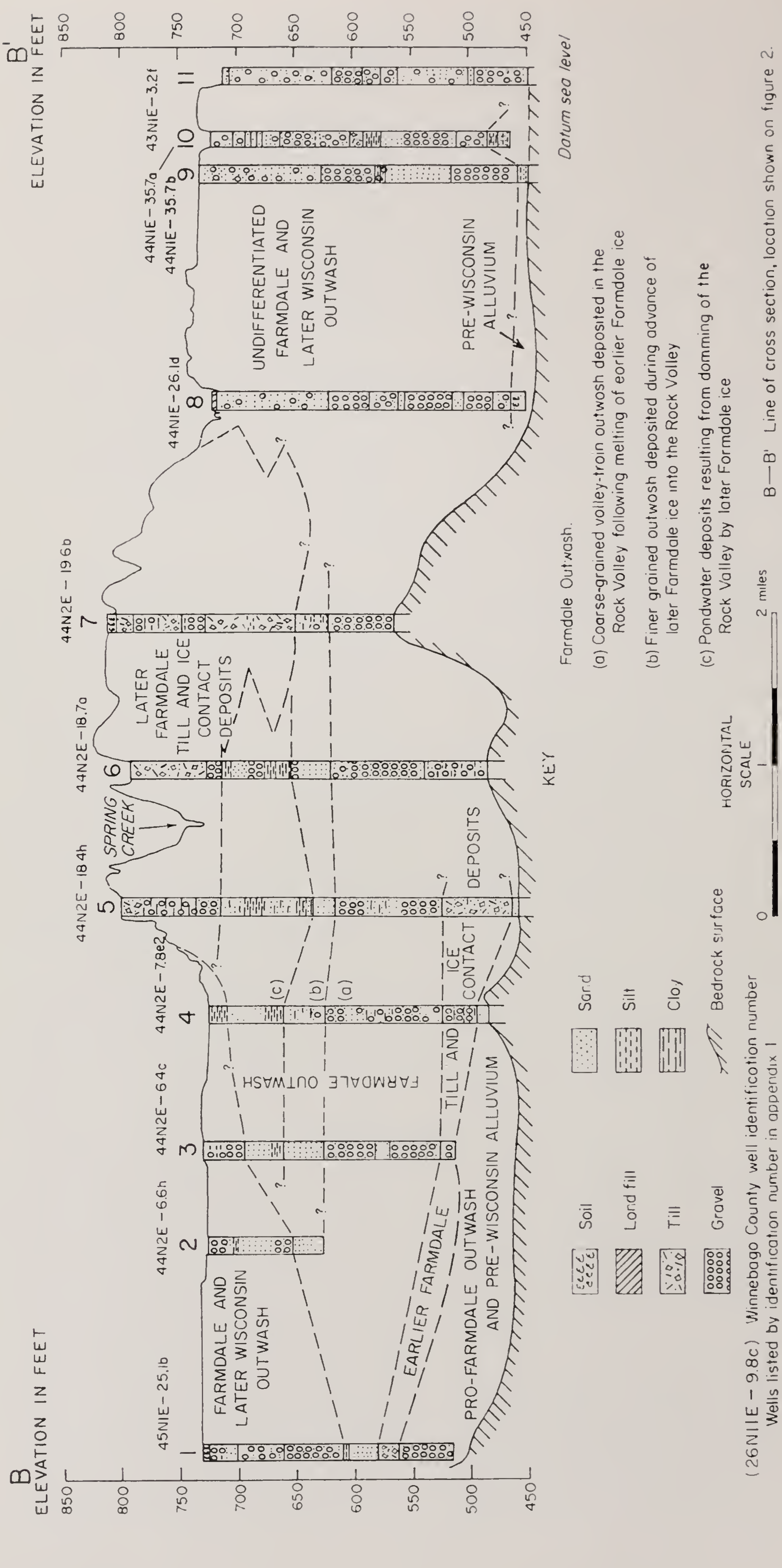


FIG. 7.—Cross section of glacial deposits in the Rock Valley at Rockford and Loves Park.

only that the deposit is older than the Farmdale and younger than the erosion of the deep bedrock channel. In central Illinois basal sands of considerable thickness and extent directly overlie bedrock in the ancient Mississippi and Mahomet bedrock valleys and are known as the Sankoty and Mahomet sands (Horberg et al., 1950, p. 34-35; Horberg, 1950, p. 51-52; 1953, p. 12-20). Stratigraphic relationships in central Illinois suggest that these sands are at least as old as early Kansan and possibly as old or older than Nebraskan in age (Horberg, 1953, p. 4). Sand deposits that may be of this same age also occur in the lower part of the ancient Rock Valley in LaSalle and Bureau Counties near the junction of the ancient Rock and Mississippi Valleys (Horberg, 1953, p. 20). Because of the character and stratigraphic position of the basal sands at Rockford, they may be equivalent in age to the Sankoty and Mahomet sands of central Illinois.

The depth of the basal sand deposit, its restricted occurrence, and its thinness so limit its water-yielding potential that it is of negligible value as an aquifer in Winnebago County.

FARMDALE GLACIATION AND DRAINAGE CHANGES

The Farmdale glacier advanced westward from the Lake Michigan basin, covered all Winnebago County (fig. 8), and at maximum extended to the border of the unglaciated area of northwestern Illinois (Shaffer, 1956, p. 5, fig. 2). The Farmdale ice moved over the rugged topography inherited from a long period of erosion—a topography that strongly influenced the nature of the glacial debris deposited during the melting of the glacier.

West of the Rock River in Winnebago County, the glacial deposits show (Flint, 1931, p. 431) that, after its advance, the Farmdale ice stagnated. The ice melted first from the bedrock uplands where it was thinnest, leaving blocks of stagnated ice in the valleys and depressions. Escaping meltwater, where it was forced to bypass drainage valleys filled by ice or till, eroded new channels into the bedrock.

Although the advance of the Farmdale ice across Winnebago County and the subsequent stagnation caused many drainage diversions and alterations in the tributary valleys, the major valleys were little altered. Only in the Rock Valley at Rockford has any change been observed in the width of the valley from that established before glaciation. There the old valley is buried by a till spur that abuts against the west wall, and the Rock River flows over a rock floor in a relatively narrow valley.

Evidences of the drainage diversions in the city of Rockford and the subsurface relations of the glacial deposits associated with the till spur provide significant information on the history of Farmdale glaciation in the Rock River Valley. As shown by logs of the Bradley Heights subdivision well (WIN 44N2E-18.4h) and the Loves Park test well (WIN 44N2E-6.4c, fig. 7), till of an early Farmdale ice advance lies deep within the Rock Valley and is overlain by glacial outwash. The "dirty" gravel shown near the base of the log of the Woodward Governor well no. 3 (WIN 44N2E-7.8e2) may be a gravelly till or may represent ice contact deposits associated with the ice advance. At places in the ancient Rock Valley, for instance at the North Park well no. 1 (WIN 45N1E-25.1b), the deeply buried till overlies coarse gravel that probably represents Farmdale outwash deposited in the Rock Valley when the Farmdale ice invaded the area from the east.

The spur of glacial till across the Rock Valley at Rockford and the subsurface relations of the alluvial fill indicate that a second advance of the Farmdale ice moved across the valley at least to the west valley wall. In the Rock Valley the tills of the two advances of the Farmdale ice are separated by several tens of feet of outwash sand and gravel.

Beneath and north of the till spur at Rockford a distinct textural change occurs in the outwash at an elevation ranging from 615 to 625 feet, as shown by the logs in figure 7. Below this elevation and over-

lying the till deposits of the earlier Farmdale ice, the outwash is predominantly coarse-textured gravel. Above this elevation the water-laid deposits are finer textured and consist predominantly of fine sand, silt, and clay. The abrupt change from coarse-textured to fine-textured outwash is a result of the ponding of meltwaters in the Rock Valley by the later advance of the ice. Lack of evidence of weathering or erosion on the upper surface of the coarse-textured outwash indicates that the interval of time between the deposition of the coarse-textured materials and the overlying fine-textured materials must not have been great. Melting of the ice dam allowed ponded meltwater to escape along a drainage way between the newly deposited glacial till spur and the west wall of the Rock Valley—a course now followed by the Rock River. With resumption of through-drainage, coarse-textured outwash again was deposited in the valley north of the till spur.

South of the till spur the outwash deposits differ from those just described. It appears that during part of the time the meltwater was ponded north of the ice dam through-drainage continued to the south and coarser textured valley-train materials were deposited.

Locally, as at Rockford city well no. 14 (WIN 44N1E-35.7a, fig. 7 and appendix 2), there is evidence that meltwater was ponded south of the till spur long enough to allow widespread deposition of fine sands and silts. That the ponding of the meltwater probably was caused by an advance of glacial ice across the valley is indicated by the till layer between elevations of 590 and 600 feet overlying pondwater silts and clays in this well. Probable pondwater deposits have been reported in other wells in the area south of the till spur. According to the engineer's report on the water supply for the Rockford Sewage Treatment Works in the NE¼ NW¼ NW¼ sec. 11, T. 43 N., R. 1 E., "clay" was encountered at a depth of 100 feet and extended to a depth of 150 feet in wells drilled at the treatment plant. The wells for the Camp Grant water supply on the floodplain of the Rock River in the NW¼ SW¼ sec. 11, T. 43 N., R. 1 E., are reported to have penetrated 10 to 20 feet of "clay" between depths of 90 to 130 feet below the level of the floodplain (elevation ±695 feet, estimated from topographic map) (Bretz, 1923, p. 301).

Although these fine-textured deposits are not found in all logs of wells drilled in this part of the valley (fig. 7), their presence at a consistent elevation suggests that they represent remnants of a formerly continuous deposit formed in a quiet-water environment. The till overlying these deposits in well WIN 44N1E-35.7a strongly suggests that through-drainage in the Rock Valley was arrested for a short period by the movement of ice into the valley at some location south of the Camp Grant wells and, shortly after, into the Camp Grant and south Rockford area. Deeply cut drainage channels within two miles west of the valley wall indicate that the later Farmdale ice did not extend much beyond the west valley wall. These drainage channels probably represent the course of an ice-marginal stream that acted as an outlet for the ponded meltwaters north of the ice dam.

One of these drainage channels is within the city of Rockford in the southern part of sec. 15 and the northern part of sec. 22, T. 44 N., R. 1 E. There the North Fork of Kent Creek flows southward through a gorge-like valley. Wells drilled for the Rockford Consolidated Dairy Company (WIN 44N1E-15.3c) and for the Hess and Hopkins Tannery (WIN 44N1E-22.3g) penetrate about 100 feet of valley fill along Kent Creek and enter bedrock at elevations of 625 and 620 feet, respectively. As estimated from the present elevation of the bedrock divide, a channel at least 155 feet deep must have been eroded in dolomite bedrock by glacial meltwater during ice occupation.

Again, near the junction of the north and south forks of Kent Creek, the stream occupies a valley cut across a bedrock spur. Well data shown on plate 1 suggest that the bottom of this valley was cut through dolomite to an elevation of nearly 600 feet.

A similar channel is present at Blackhawk Park in sec. 34, T. 44 N., R. 1 E., ap-

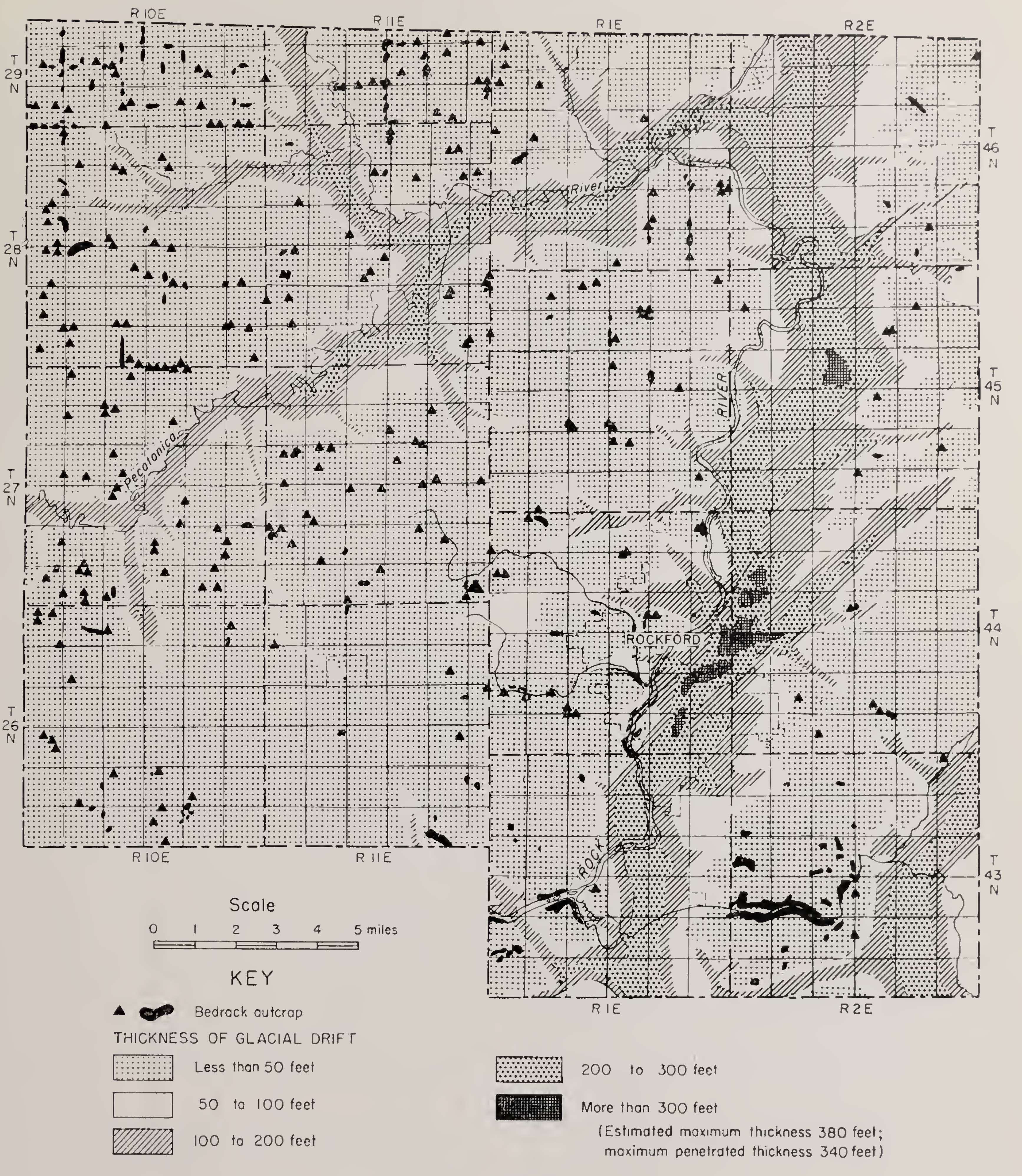


FIG. 8.—Thickness of glacial drift in Winnebago County.

proximately one mile south of the junction of Kent Creek and the Rock River where the river occupies a gorge-like valley cut into dolomite bedrock. As shown on the map of the bedrock surface (pl. 1), well data indicate that this valley has been incised to an elevation of less than 600 feet. Immediately east of this rock-walled channel is the broad lowland of the partly filled Rock Valley. The surface relations indicate that the ancient valley was filled with glacial ice while this narrow valley was being eroded into the bedrock by glacial meltwaters.

SHELBYVILLE GLACIATION AND DRAINAGE CHANGES

During the early part of Tazewell time, the south part of southeastern Winnebago County was invaded by ice of the Belvidere lobe (Leighton, 1923, fig. 1). The ice moved generally northward and westward into the county, about as far as the Kishwaukee River and the narrows of the Rock River.

The advance of the ice over the partly filled Rock and Troy Valleys caused extensive drainage diversions and contributed additional outwash materials to the fill of these valleys. A few miles south of the Winnebago county line the Rock Valley is completely buried by Shelbyville drift and all surface expression of the ancient valley is obliterated. The Shelbyville ice at its position of maximum advance stopped drainage down the Rock and Troy Valleys. As a result, the drainage was diverted into ice-marginal streams across bedrock divides through which new valleys were cut. The narrow rock-walled valleys of the Kishwaukee River east of New Milford and the Rock River at the county line are ice-marginal valleys eroded during the maximum advance of the Shelbyville ice.

Along the northern and western border of Killbuck Creek between a half and 2½ miles south of New Milford are several gravelly tracts in which gravel occurs in small kame hills well above the general level of the surrounding glacial till. The coarse gravel contained in these upland deposits accumulated at the ice margin where streams emerging from the ice suddenly decreased in velocity. The kames in these tracts probably were built consecutively as the margin of the glacial ice melted back toward the east (Bretz, 1923, p. 254).

Meltwater from the retreating Shelbyville ice was discharged into the lowlands of the Rock and Troy Valleys. Shelbyville outwash cannot be distinguished from the older or younger outwash but it may constitute only a small part of the sand and gravel fill in these valleys.

POST-SHELBYVILLE DEPOSITS

Meltwater from the Bloomington ice carried outwash sand and gravel northward into the county along Killbuck Creek and the South Branch of the Kishwaukee River (Bretz, 1923, pl. VI). Some Bloomington outwash also came from the northeast along the present route of the Kishwaukee River.

During Cary time the glacier readvanced from the Green Bay lobe and built the Johnstown moraine across Rock Valley near Janesville, Wisconsin (Alden, 1918, p. 209-211, pls. III, XXIII). South of this morainal border extensive outwash deposits of coarse sand and gravel occupy the wide valley area of the Rock River and extend into Winnebago County. Cary outwash also was transported into Winnebago County from the north along the valley of the Sugar River.

The coarseness of the Cary outwash decreases downstream. Near South Beloit and east of Rockton the surficial outwash deposits are coarse-textured; commercial gravel pits have been extensively developed in them. In the North Park and Loves Park area the near-surface deposits are finer textured. This textural change probably reflects the influence of the drainage restriction caused by the till spur at Rockford as well as the normal change in texture of deposits with distance from the source. South of the till spur, deposits of Cary age may be thin or absent.

WATER-BEARING PROPERTIES OF THE GLACIAL DEPOSITS

Water-bearing properties of the glacial drift are extremely variable because the deposits vary in composition, texture, sorting, thickness, and lateral extent. Glacial deposits containing a large proportion of well sorted, coarse-grained materials such as the sand and gravel that occur as valley-train outwash are the most permeable. Tills and slackwater deposits that contain a large proportion of fine-grained materials allow ground-water movement only at a slow rate and generally are unsatisfactory as aqui-

fers. They may, however, store large quantities of ground water.

The sands and gravels of the outwash deposits range from very fine grained to very coarse grained, and the sorting ranges from excellent to poor. Glacial outwash deposits are characterized by many lateral and vertical changes in character and thickness, which result in corresponding variations in the transmissivity of the deposits. Test drilling preliminary to construction and development of medium or large capacity wells generally is necessary to 1) establish the presence of suitable aquifer material, 2) determine the most satisfactory well location in a material of varied character, 3) select the most permeable zone or zones for development, and 4) provide the information necessary for proper well design and construction.

Deposits of fine- to medium-grained silty sand of relatively low permeability occur in the valley fill. Much of the valley fill in the Pecatonica and Sugar Valleys and the upper portion of the fill in the ancient Rock Valley south of the Kishwaukee River contain extensive deposits of fine-grained outwash that is generally unsatisfactory for well development. The water in the sands generally is under hydrostatic head conditions that cause the material to be "quick" and considerable difficulties from caving or "running" sand are encountered during well construction.

In valleys where deposits of silt and clay underlie the valley floor, such as the Pecatonica and Sugar River Valleys, ground-water recharge to underlying glacial and bedrock aquifers and upward discharge of ground water from these aquifers is greatly restricted. In some valleys near-surface outwash may be separated from older valley fill outwash by widespread deposits of till of low permeability. The till retards the movement of ground water and may allow the development of a difference in the hydrostatic heads of the aquifers. In areas where the deeper aquifers are heavily developed, local recharge from the surface is restricted by this till.

Ice-contact sands and gravels that are extremely variable in texture and sorting are scattered throughout the county. Some, such as the upland gravels in the vicinity of New Milford, occur as surficial deposits overlying glacial till. Other ice-contact deposits are interbedded within the till or occur on the sides of drainage valleys that contained stagnant ice blocks. Although the permeability of the deposits may be very high, the rapid changes in their character and thickness and their usually limited extent generally make them unsuitable for large-scale ground-water development. They may be excellent aquifers for small-capacity wells.

The till that blankets most of the uplands of Winnebago County contains a large proportion of fine-grained materials and is poorly sorted. The low permeability of the till prevents it from yielding economic amounts of water to drilled wells, but it may provide usable quantities of water to large-diameter dug or augered wells. Although water movement through the till is relatively slow, recharge into or discharge from adjacent aquifers does occur.

GROUND WATER

Occurrence and Movement

The vast reservoir of ground water that underlies Winnebago County is contained in sediments of Cambrian, Ordovician, and Pleistocene age. This reservoir is continually replenished by precipitation that falls on the land surface in and adjacent to the county and by streams flowing into the county. The amount of water stored in the ground-water reservoir depends on the amount and distribution of recharge from precipitation and streams; the thickness, extent, and porosity of the water-containing rocks; the recharge characteristics of the soil and surficial deposits; and the base-levels of ground-water discharge.

Recharge to, movement within, and discharge from the ground-water reservoir are complicated by variations in permeability between and within the reservoir rocks and by the relief and configuration of the land surface. Ground water generally moves from the uplands to the valleys, which are

the principal areas of discharge. In the glacial drift and shallow bedrock aquifers, ground-water movement is closely related to the configuration of the land surface. In the deeper lying sandstone aquifers, ground water moves from the higher land areas along the eastern and western borders of the county toward the low-lying valley of the Rock River (Smith and Larson, 1948, p. 15, fig. 3). Movement in other confined beds generally is from higher to lower land but not necessarily closely related to the surface configuration.

In the early investigations of the deep artesian aquifers of northern Illinois it was assumed that the source of recharge to the deep sandstone aquifers was in central and southern Wisconsin where these formations crop out. Recent studies in northern Illinois and southern Wisconsin have shown, however, that recharge to these deep aquifers takes place locally in areas where the hydrostatic head in the water table aquifers exceeds the head in the confined aquifers. Water recharging the deep aquifers moves downward through hundreds of feet of overlying strata in many places throughout the area where the Galena Dolomite or older formations form the uppermost bedrock surface (Foley and Smith, 1954, p. 231; Suter et al., 1959, p. 59) and where such head differential exists.

The stratification and variation in texture of the sedimentary deposits underlying Winnebago County result in changes in permeability in the direction normal to stratification. Because the more permeable water-bearing rocks generally lie between deposits of lower permeability, water in the more permeable deposits is more or less confined under hydrostatic pressure and artesian conditions predominate in the aquifers. Because the confining layers do transmit ground water, although necessarily at a lower rate, ground water moves to and from aquifers in response to the pressure difference involved. If the hydrostatic head in the artesian aquifer exceeds the hydrostatic head in the confining bed, water moves from the aquifer toward the confining bed. If, however, the hydrostatic head in the confining bed exceeds the hydrostatic head in the artesian aquifer, water moves toward the aquifer.

Water-table aquifers occur in areas where permeable glacial deposits immediately underlie the land surface and in the upland areas where the top of the zone of saturation lies within the Paleozoic bedrock.

Geohydrologic Units

The geologic formations of Winnebago County and their water-bearing properties have been described. On the bases of character and origin of the deposit, stratigraphic position, water-bearing properties, and utilization, these rocks also can be grouped into two general geohydrologic units—glacial drift aquifers and bedrock aquifers. The bedrock aquifers can be further classified as Ordovician aquifers (subdivided into dolomite aquifers and sandstone aquifers) and Cambrian aquifers.

Glacial Drift Aquifers

The relatively coarse-textured unconsolidated sands and gravels deposited principally as glacial outwash constitute the aquifers of Pleistocene age. Glacial outwash related to several ice advances occurs within the county, but the deposits associated with glacial activity during the Farmdale substage appear to be thickest, most extensive, and most widely used as aquifers.

Ground water in the glacial drift aquifers occurs under a variety of hydrologic conditions. In areas where coarse-textured permeable deposits are at or very near land surface, ground water may occur under water-table conditions. Where permeable deposits lie beneath the top of the zone of saturation and are overlain by relatively impermeable deposits, artesian conditions prevail. Because of the extremely varied character of glacially derived sediments, the deposits that function as confining layers have a wide range of permeability. As a consequence, leaky artesian conditions are common.

In an earlier study of the chemical quality of water from the glacial drift aquifers (Smith and Larson, 1948, p. 23-26) it was

concluded that the waters were of two distinct chemical types. The water defined as being from "pre-Wisconsin drift" (probably Farmdale and younger) * deposits is characterized by 1) an iron content greater than 0.3 parts per million (ppm), 2) hardness greater than 300 ppm, 3) sulfate content less than 20 ppm, and 4) chloride and nitrate content less than 3 ppm.

The second class of water occurring within the glacial drift was classified as local recent recharge waters from rainfall or river infiltration passing through loess and loam deposits. These waters are characterized by 1) nitrate content generally greater than 10 ppm, 2) hardness greater than 400 ppm, 3) sulphate content greater than 50 ppm, 4) chloride content greater than 20 ppm, and 5) iron content less than 0.4 ppm.

The sand and gravel aquifers are limited chiefly to the valley areas where the thickness of the glacial drift is greatest (fig. 8). The large volumes of meltwater discharged into these valleys deposited large quantities of sand and gravel, silt, and clay that nearly filled the valleys and, in some areas, formed extensive aquifers of high permeability. The nature and distribution of the valley-fill materials are related chiefly to the orientation of the valleys in relation to the direction of ice movements and the various positions of the ice fronts.

Where valleys such as the Rock Valley, and probably Troy Valley, served as drainageways that carried meltwater away from the ice fronts, coarse-textured and permeable deposits of sand and gravel outwash constitute a large part of the valley fill. Where the normal direction of drainage in the valleys was toward the ice front or where streams were ponded, as in the Pecatonica and Sugar Valleys, a large part of the valley fill consists of backwater silt and fine sand of relatively low permeability.

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*As the bulk of the valley fill in the Rockford area is outwash associated with the Farmdale glaciation, the water classified by Smith and Larson as pre-Wisconsin probably is associated for the most part with Farmdale deposits.

†In this report the terms Pecatonica Valley, Rock Valley, etc., refer to the older valleys eroded prior to glaciation of the region. The terms Pecatonica River Valley, Rock River Valley, etc., refer to the present land surface valleys in which there are streams or rivers.

Aquifers in the Rock Valley†

Large supplies of ground water, such as are required for municipal and industrial purposes, are found in the Rock Valley. In most of the valley area, the coarse-textured outwash is more than 100 feet thick and large capacity wells are developed at depths of less than 300 feet. Permeable outwash deposits commonly extend to land surface, allowing rapid recharge from surface streams and precipitation where water levels have been lowered sufficiently by pumpage.

In most of the Rock Valley the extensive and permeable aquifers are undeveloped. Only in the vicinity of Rockford has there been any concentrated development by large capacity wells. The city of Rockford has used these aquifers since 1947 when testing of city well 7A (WIN 44N1E-36.6f) gave a specific capacity of 72 gallons per minute per foot of drawdown, which is 3 to 5 times greater than that of the deep sandstone wells (Smith and Larson, 1948, p. 22).

The principal glacial aquifer for industrial and municipal water supplies in the Rockford–Loves Park area consists of extensive, continuous deposits of coarse-textured valley-train outwash that occurs in the basal part of the valley fill. The upper part of the valley fill, generally above an elevation of 625 feet, is somewhat less uniform. In the vicinity of Loves Park and the till spur at Rockford, the outwash in the upper part of the valley fill is generally finer grained than that in the basal part, although it does contain sand beds of sufficient permeability to supply water for domestic and other wells of small demand. The highest capacity wells generally are developed in the basal part of the valley fill and range from 150 to 300 feet deep. South of the till spur, the upper part of the valley fill is generally coarser textured than the deposits north of the spur, but the highest capacity wells here, too, are developed in the basal part of the valley fill.

The small amount of information available for the area north of Rockford and Loves Park indicates that the upper part of

the valley fill becomes generally coarser to the north. The drillers log of the Wisconsin Power and Light Company well no. 3 (WIN 46N2E-5.7d) provides a description of generally coarse-to-fine gravel above a depth of 122 feet. Below this depth the outwash material contains interbedded coarse gravel, sand, and "shale" (probably clay or silt) to 225 feet. This well is within the deep channel of the valley near the north line of the county.

Well WIN 46N2E-28.7h was drilled through the following sequence of materials.

Warner Electric Brake and Clutch Company plant no. 2 well (WIN 46N2E-28.7h) drilled in 1956 by J. H. Allabaugh, Rockford. Total depth 96 feet. Elevation 755 feet, estimated from topographic map. Correlated drillers log.

	Thickness (*ft*)	*Depth* (*ft*)
Pleistocene Series		
Top soil and fill	5	5
Sand and gravel	30	35
Sand and medium gravel	38	73
Gravel and fine sand	9	82
Sand and pea gravel	6	88
Large stones and gravel	8	96

According to the drillers report, 18 feet of 100 slot, 10-inch diameter screen bottoming at 97 feet was set in the well and during an 8-hour pumping test the well was pumped at a rate of 670 gpm with a drawdown of 18 feet, nine inches from a static level at 34 feet. This shows that in the northern part of the Rock Valley there is a good probability of developing wells of medium to high capacity at depths of less than 150 feet.

Discharge in the tributary valleys along the eastern side of the Rock Valley was, for the most part, away from the ice. These valleys are therefore more likely to contain thick, continuous deposits of permeable sand and gravel outwash than are the tributary valleys on the western side of the Rock Valley.

The following well records indicate the nature of the material filling a tributary valley on the eastern side of the northern part of the Rock Valley about 4 miles east and 2 miles south of Rockton:

WIN 46N2E-26.8a. Elevation 840 feet, estimated from topographic map. Total depth 70 feet.

	Thickness (*ft*)	*Depth* (*ft*)
Pleistocene Series		
Sand and gravel	70	70

WIN 46N2E-27.1a. Elevation 840 feet, estimated from topographic map. Total depth 145 feet.

	Thickness (*ft*)	*Depth* (*ft*)
Pleistocene Series		
Dirt	20	20
Sand and gravel	125	145

Tributary valleys on the western side of the Rock Valley are likely to be filled with glacial till or fine-textured alluvium. This is indicated by the following record of a well drilled in a large tributary valley that enters the ancient Rock Valley northwest of Loves Park.

G. C. Brown well (WIN 45N1E-36.8d). Elevation 730 feet, estimated from topographic map. Drilled 1910. Total depth 128 feet.

	Thickness (*ft*)	*Depth* (*ft*)
Pleistocene Series		
Soil	10	10
Blue clay	115	125
Gravel	3	128

Locally the fill in the western tributary valleys may contain considerable thicknesses of sand and gravel, such as that at the site of well no. 1 of the Atwood Vacuum Machine Company.

Atwood Vacuum Machine Company well no. 1 (WIN 44N1E-11.1c) Elevation 745 feet, estimated from topographic map. Drilled by Varner Well Drilling Company, 1943. Total depth 709 feet. Illinois State Geological Survey sample set 10832. Studied by M. P. Meyer.

	Thickness (*ft*)	*Depth* (*ft*)
Pleistocene Series		
No samples	30	30
Sand and granular gravel, yellow, clean	53	83
Gravel, coarse, clean	7	90
Gravel and sand, slightly silty	15	105
Gravel, coarse, clean	10	115
Sand, yellowish buff, very silty	10	125
Sand and granular gravel, white to yellow, silty	15	140
Till, calcareous, brown	15	155
Sand and gravel, buff, silty	25	180
Sand, buffish yellow, silty	35	215
Clay, yellowish buff, sandy, silty	4	219
Gravel, yellow	6	225
Bedrock below		

The restricted extent of these deposits is indicated by the log of the W. F. and John Barnes Company well (WIN 44N1E-11.1b), located just south of the Atwood Vacuum Machine Company well no. 1, which shows the glacial fill to be 145 feet thick and to consist predominantly of glacial till with minor thicknesses of clean sand and gravel.

Aquifers in the Pecatonica and Sugar Valleys

Throughout most of the glacial history of Winnebago County the drainage in the Pecatonica and Sugar Valleys was ponded by the various glacial advances and the large volumes of glacial meltwaters that were being discharged down the Rock Valley. As a result, these valleys contain a large proportion of fine-textured sediments.

Although the valley fill in the eastern part of the Pecatonica Valley attains a maximum thickness of more than 200 feet over the deepest part of the channel, most of the fill is from 100 to 200 feet thick (fig. 8). The character of the valley fill near the junction with the ancient Rock Valley is indicated by the following well record.

Fred Wieland well (WIN 46N1E–13.4c) drilled 1948 by Bloyer and Dennis, South Beloit. Total depth 230 feet. Elevation 750 feet, estimated from topographic map. Correlated drillers log.

	Thickness (*ft*)	*Depth* (*ft*)
Pleistocene Series		
Coarse gravel	15	15
Fine sand	65	80
Sand and clay	80	160
Fine sand	45	205
Ordovician System		
St. Peter Sandstone		
Sandstone, brown	25	230

The preponderance of fine sand and the lack of coarse-textured deposits reported in the above well log indicate that the deposits in the Pecatonica and Sugar Valleys are in general likely to yield less water than the thick, coarse-textured deposits that characterize the Rock Valley.

Locally, coarse-grained deposits are found in the Pecatonica and Sugar Valleys. The following partial log of the Atwood Fish Farm well no. 2 (WIN 27N11E-6.4e) shows the beds of clean, coarse-textured sand and gravel in the Pecatonica Valley.

Atwood Fish Farm well no. 2 (WIN 27N11E–6.4e) drilled June 1944 by Varner Well Drilling Company. Total depth 606 feet. Elevation 728 feet, estimated from topographic map. Illinois State Geological Survey sample set 11202. Studied by M. P. Meyer.

	Thickness (*ft*)	*Depth* (*ft*)
Pleistocene Series		
Silt, dark brown, coarse, micaceous, noncalcareous	15	15
Silt, brown, micaceous with fine quartz and sand grains	10	25
Sand, brown, very fine to coarse, very silty	5	30
Sand, quartz and dolomite grains, buff, fine to coarse, clean	15	45
Sand and little gravel, clean	15	60
Clay, calcareous, brown, carbonaceous	25	85
Silt, sandy, calcareous, brown, carbonaceous, micaceous	10	95
Clay, sandy, calcareous, brown	10	105
Sand, calcareous, brown, medium, very silty	5	110
Clay, calcareous, brown, micaceous, with few sand grains	20	130
Sand, white, medium to coarse, clean	4	134
Gravel, coarse	9	143
Sand, quartz and dolomite, buffish yellow, fine to medium, very silty at top	32	175
Sand, white, medium to coarse, few dolomite grains; chert, white, brownish yellow coating	5	180

Coarse-textured outwash suitable for ground-water development may be widespread throughout the Pecatonica and Sugar Valleys or may occur only in local beds or lenses of limited extent. Sufficient subsurface information upon which to base a detailed description of the character, sequence, or distribution of the valley-fill deposits or to evaluate their water-yielding character is not available over a large area in the valleys.

Deposits in the tributary valleys of the Pecatonica and Sugar Valleys consist principally of fine-textured material like that in the major valleys. However, they locally contain coarse-textured outwash. Coarse-textured outwash is reported in the drillers record of the Durand Village well, which is in a large tributary of the Sugar Valley.

Durand Village Well no. 1 (WIN 28N10E–10.5b). Elevation 772 feet, estimated from topographic map. Drilled 1920 by A. McMahon. Total depth ± 180 feet.

	Thickness (ft)	*Depth (ft)*
Pleistocene Series		
Dirt	17	17
Quicksand	35	52
Gravel	15	67
Coarse sand	113	180
Ordovician System		
St. Peter Sandstone		
White sandstone	below	

Such outwash deposits probably are limited in extent and often are unpredictable in occurrence. Where present, however, they may prove to be valuable sources of water for small to medium supplies.

Aquifers in the Troy Valley

The deposits that fill the Troy Valley attain a maximum thickness of nearly 300 feet along the western side of the valley approximately one mile east of the rock-walled channel of the Kishwaukee River (fig. 8). This area, which was covered by the Shelbyville ice, is underlain by an estimated maximum thickness of 200 feet of sand and gravel outwash below nearly 100 feet of clayey deposits, probably till. A log of well WIN 43N2E-22.1d2 in this part of the Troy Valley shows the following sequence of deposits:

	Thickness (ft)	*Depth (ft)*
Pleistocene Series		
Drift	90	90
Gravel and quicksand	175	265

The "drift" in the above log is probably till as is suggested by the log description "85 feet of clay to gravel" in another well at this location. If the upper 85 to 90 feet of material in the well logs is till deposited by the Shelbyville ice, the underlying outwash deposits may be chiefly Farmdale in age, as are the outwash deposits in the Rock Valley to the west.

Outwash deposits from the Shelbyville and Bloomington advances underlie the lowlands of the Kishwaukee River and its south branch. The thickness and character of the outwash are not known from well records, but some sand-point wells indicate that these deposits are a suitable source of small ground-water supplies.

Locally in the Troy Valley the surficial outwash in the lowland areas probably is separated from deeper lying valley-fill outwash by deposits of glacial till of variable thickness.

Medium to large quantities of water probably are available throughout the Troy Valley in Winnebago County but only small supplies are withdrawn. The nature, distribution, extent, and water-yielding character of the valley fill are untested, but geologic evidence indicates that it is a promising area for future development of ground-water supplies.

Aquifers in the Glacial Valleys

Drainage diversions caused by glaciation in Winnebago County resulted in the erosion of narrow gorge-like valleys that, in some instances, contain considerable thicknesses of glacial fill. The principal glacial valleys are the valley of the North Fork of Kent Creek in Rockford, the narrows occupied by the Rock River at Blackhawk Park, the narrow Kishwaukee Valley east of New Milford, and the narrow Rock Valley southwest of the junction of the Rock and Kishwaukee Rivers.

The thickness of the fill in these valleys is determined principally by the depth to which the valleys were cut. In general, the valleys eroded during Farmdale time are more deeply cut than those eroded during Shelbyville time, indicating that the local base-level of erosion was lower during Farmdale time than during Shelbyville time.

Deposits in the gorge-like valley of the North Fork of Kent Creek in Rockford attain a maximum thickness of about 125 feet. The general character of the deposits of the valley fill is indicated by the following record:

Rockford Consolidated Dairy Company well (WIN 44N1E–15.3c). Drilled in 1929–1930 by P. E. Millis and Company. Total depth 1125 feet. Elevation 725 feet, estimated from topographic map. Illinois State Geological Survey sample set 965. Studied by E. T. Benson.

	Thickness (*ft*)	*Depth* (*ft*)
Pleistocene Series		
No sample	8	8
Sand, colorless, iron-stained, medium, cherty, incoherent, clean	15	23
Sand, colorless, pink, medium, coarse, cherty, dirty	15	38
Sand, light, coarse, cherty	15	53
No sample	5	58
Gravel, clean, medium, dolomitic, cherty	27	85
Gravel, dirty, medium, dolomitic, cherty	17	102

These deposits probably are highly permeable aquifers. However, the narrow width of the rock-walled valley will limit the quantity of ground water that can be developed in the area.

At Blackhawk Park in sec. 34, T. 44 N., R. 1 E., the Rock River occupies a narrow rock-walled channel apparently cut by a stream marginal to the Farmdale ice. The valley probably was eroded to an elevation of less than 600 feet above mean sea level and the maximum thickness of fill in this valley is estimated to be about 115 feet. The possible presence of coarse-textured outwash underlying the river floodplain and the availability of ready recharge from the Rock River suggests that wells of medium to large capacity may be developed at relatively shallow depths.

The narrow valley of the Kishwaukee River was eroded by glacial meltwaters during the maximum stand of the Shelbyville ice, as was the narrow valley of the Rock River southwest of old Camp Grant, now the Rockford municipal airport.

The fill in the Kishwaukee gorge, although estimated to be generally less than 50 feet thick (fig. 8), is likely to be coarse-textured outwash from the Shelbyville and Bloomington glaciers. Locally, in the thicker parts of the valley fill, the permeability of the outwash and surface recharge from the Kishwaukee River may result in conditions favorable for the development of wells of small to medium capacity.

The part of the Rock River Valley eroded by meltwater during the Shelbyville advance is underlain by a variable thickness of glacial deposits. Within about half a mile of where the Rock River leaves Winnebago County, it crosses a deeply cut buried valley that is tributary to the ancient Rock Valley to the southeast (pl. 1). In the deepest part of the channel of the ancient tributary valley, the estimated thickness of glacial drift underlying the present valley of the Rock River is 150 feet. In the reaches of the Rock River Valley that have been eroded through bedrock, the fill beneath the present valley floor is estimated to be only slightly more than 50 feet thick.

Along the present course of the Rock River Valley, coarse-textured outwash deposited by meltwater from Shelbyville and later glacial advances is subject to recharge from the Rock River and may be satisfactory for development of wells of small to medium capacity. The glacial deposits occurring as fill in the tributary valley transected by the present Rock River are likely to consist principally of fine-textured deposits with local relatively thin beds of coarser textured permeable deposits.

Distribution

The preceding discussion of the character of the glacial drift, the history of its deposition, and its water-bearing characteristics allows for the interpretation of the occurrence and distribution of sand and gravel aquifers shown in figure 9. Extensive, highly permeable sand and gravel aquifers more than 100 feet thick are continuous along the Rock Valley where a large part of the fill is coarse-grained outwash. These aquifers are suitable for large-scale municipal and industrial well development and are the most heavily used glacial aquifers in the county.

Marginal to the area of the thick, extensive deposits along the Rock Valley and in other deep valleys of the county are deposits of glacial drift of variable thickness containing aquifers of varying permeability. Although these aquifers are not as likely to have transmissivity as consistently high as that of the aquifers in the central part of Rock Valley, the probability of obtaining small to medium supplies of ground water is good and, locally, conditions may be satisfactory for the development of large supplies.

Within the deeper part of the valleys, the probability of developing large supplies is

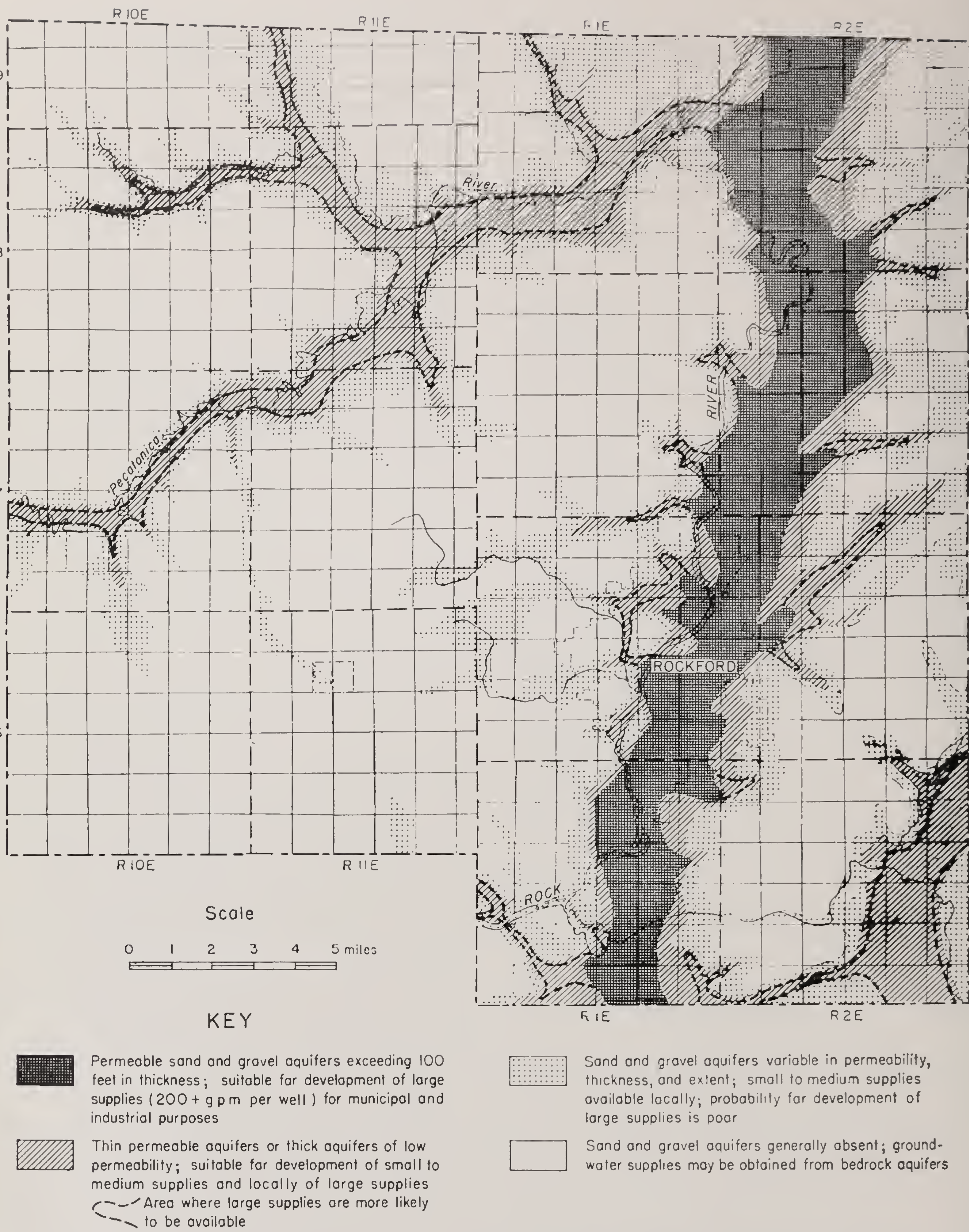

Fig. 9.—Occurrence and distribution of sand and gravel aquifers in Winnebago County.

somewhat better than in those areas where the thinner drift deposits occur. The area of best probability for the development of large-capacity wells is in the central portion of the ancient Troy Valley and in the tributary valleys along the east side of the ancient Rock Valley.

Over much of the upland areas the glacial deposits are thin and consist principally of glacial till. Sand and gravel aquifers are either absent or at such shallow depths that development by drilled wells is impractical. Locally, large-diameter wells dug to relatively shallow depths have been

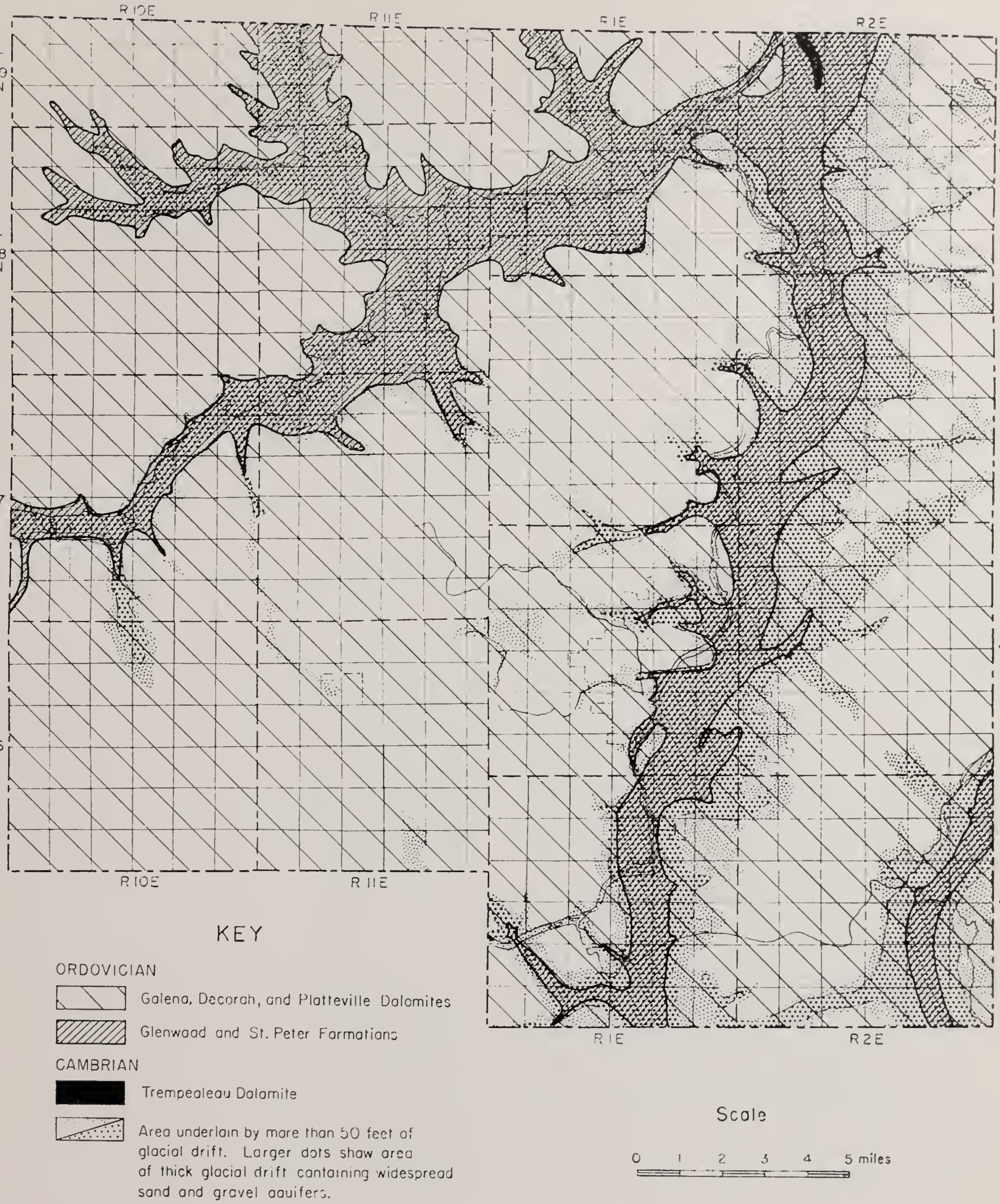

FIG. 10.—Type, distribution, and relationship of glacial drift and bedrock aquifers in contact with the drift or at land surface in Winnebago County.

constructed and some are still in use. However, the increase in water requirements by modern domestic water systems generally requires the drilling of deeper wells to the bedrock aquifers.

Between the upland areas of thin drift generally devoid of sand and gravel aquifers and the areas of thicker drift where these aquifers are generally widespread is an intermediate area where sand and gravel aquifers are sporadic in occurrence, limited in extent, and variable in permeability. In this area, small to medium supplies from glacial drift aquifers are available locally, but the probability of developing large supplies is poor.

BEDROCK AQUIFERS

The bedrock aquifers are widely used as sources of ground water for all needs. The shallow Ordovician aquifers provide ground water for domestic and smaller municipal and industrial purposes. The deeper lying Cambrian aquifers contain fresh water to a depth of at least 2000 feet below land surface, and wells drilled to them obtain sufficient quantities of water for the largest municipal and industrial requirements.

Smith and Larson (1948, p. 14, 24, 30) recognized little, if any, difference in water levels and water quality among the various bedrock aquifers. For this reason they considered the bedrock aquifers as a single hydrologic unit.

The direction of water movement in the bedrock aquifers in Winnebago County, as determined by a contour map of the piezometric surface, is toward the Rock River from the northwest and the northeast (Smith and Larson, 1948, fig. 3). The piezometric surface indicates that ground water from the bedrock aquifers is being removed from the area by discharge into the Rock River or by underflow through the valley fill.

Studies of water quality indicate that the "normal" sandstone waters of the area are somewhat less mineralized than the glacial drift waters. The sandstone waters are characterized by 1) a hardness less than 300 ppm, 2) iron less than 0.3 ppm, 3) nitrate less than 4 ppm, and 4) sulfate less than 15 ppm (Smith and Larson, 1948, p. 24).

Ordovician Aquifers

Dolomite Aquifers

The Galena, Decorah, and Platteville Formations constitute the uppermost bedrock throughout most of the county (fig. 10). Because of their wide extent, their relatively shallow depth, and consistent water-yielding zones, these formations provide water to more wells than any other geohydrologic unit in the county. Of a total of 560 well records used in this study, 244, nearly 44 percent, are of wells completed in these dolomite aquifers. Samples of drill cuttings were available for study from 80 wells in the county and of this total 28 wells were finished in the Galena Dolomite, 18 in the Decorah Formation, and 34 in the Platteville Dolomite. Considering the extent and thickness of the formations involved, the distribution indicates that the aquifer characteristics of the three formations are similar and that they may be classified as a single geohydrologic unit.

Ground water may occur under water-table conditions in areas where the upper surface of the dolomite occurs above the zone of saturation. This condition is common in the upland areas where the dolomites are overlain only by thin deposits of glacial drift. Where water-yielding crevices in the dolomites are encountered deep below the top of the zone of saturation the ground water generally occurs under artesian conditions.

A depth-frequency analysis of 216 wells drilled into the dolomite aquifers shows (fig. 11) that approximately 84 percent of the wells penetrate up to 100 feet of dolomite. Only 10 percent of these wells penetrate less than 20 feet into the dolomite. The average depth of the dolomite wells is 104 feet and the average depth of penetration into the dolomite for water supplies is 71 feet, indicating that the average thickness of cover over the dolomite is about 33 feet. Therefore, it appears reasonable to assume that in the area underlain by the dolomite aquifers of Ordovician age the majority of the wells to be drilled for domestic, stock, and other small water supplies will penetrate from 20 to 100 feet into dolomite to obtain the required amount of water.

The consistent occurrence of water-yielding zones in the dolomite and the narrow range of depth of penetration into dolomite suggest that the water-yielding character of the dolomite aquifers is a result of a well developed joint and fracture system. In other studies it has been noted that where the Galena-Platteville interval is overlain by the Maquoketa Shale, the dolomite is a less favorable source of ground water than in areas where it is exposed at land surface or overlain by glacial drift (Drescher, 1953,

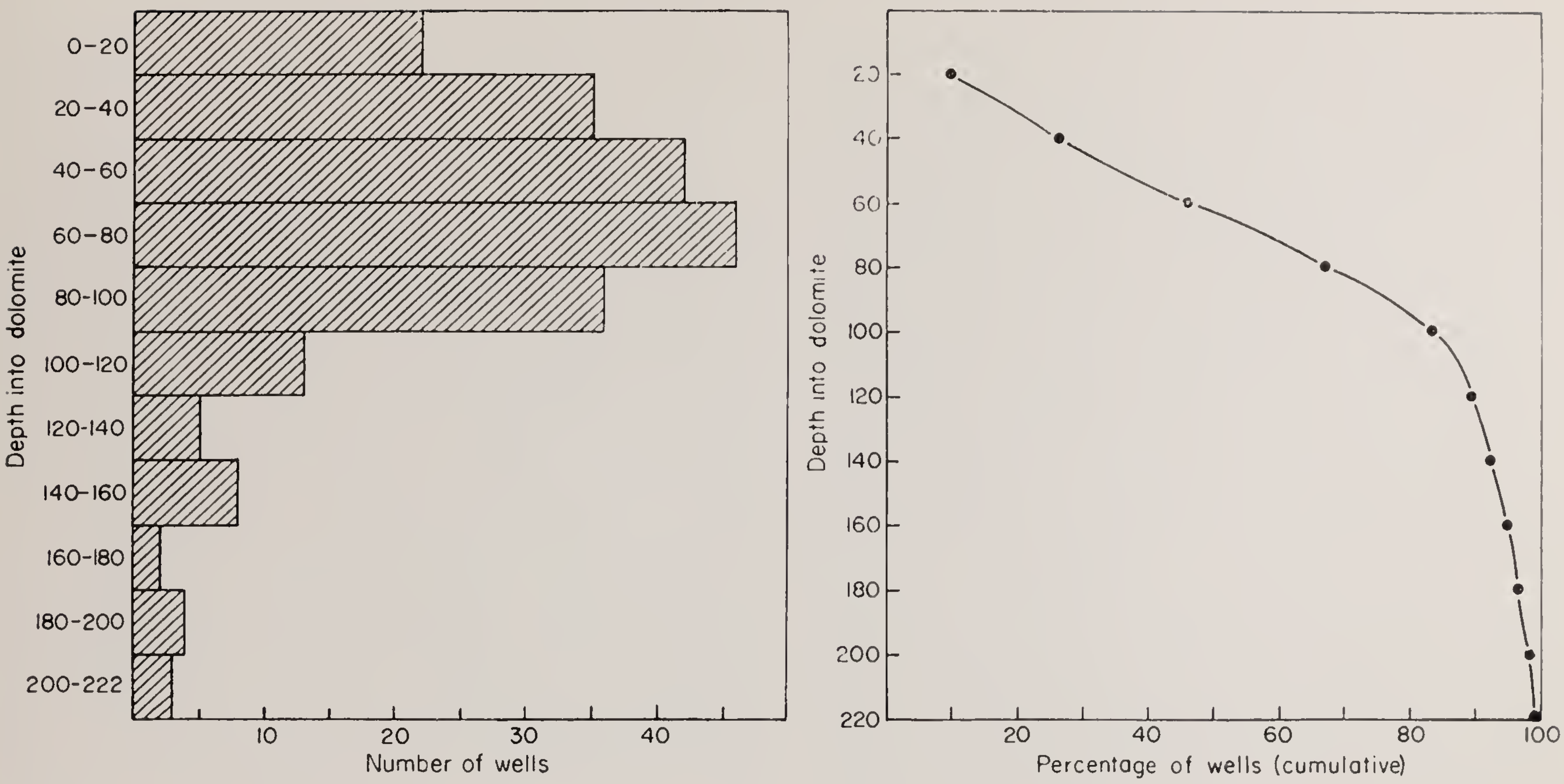

Fig. 11.—Histogram and cumulative percentage curve of wells penetrating to various depths into dolomites of the Galena, Decorah, and Platteville Formations in Winnebago County.

p. 9; Foster, 1956, p. 29). The over-all transmissivity of the dolomites depends more upon joints and fractures than bedding planes.

Solution activity has undoubtedly played an important secondary role by enlargement of the joints and fractures but apparently has not progressed sufficiently to develop areas of cavernation, which would produce extreme variability in the water-bearing properties of the dolomites.

In dense limestone and dolomite formations, underground water moves through relatively open channel ways in which there is little, if any, filtering action. As a consequence, water in these formations is more susceptible to pollution and contamination than water in granular materials like sand.

The susceptibility of dolomite aquifers in glaciated areas to bacterial pollution is related in part to the thickness and character of the unconsolidated material that occurs above the dolomite and between it and the source of pollution. To provide adequate filtration, a fine-textured material of low permeability, such as clayey glacial till, need not be as thick as a coarser textured, more permeable material. Where the material is very coarse textured, as, for instance, gravel, the intergranular openings may be so large that they are relatively ineffective in the filtration of bacteria, and protection of the underlying dolomite is dependent principally upon the relative position of the top of the zone of saturation and the direction of ground-water movement.

General standards recommended for the necessary thickness of cover between the source of pollution and the top of the dolomite to afford protection from bacterial pollution of wells in limestone and dolomite areas have been adopted by the Illinois Department of Public Health. In closely populated areas, such as suburban developments, a minimum thickness of at least 50 feet of glacial drift must overlie a limestone or dolomite aquifer if private water supplies are to be used from this aquifer without chlorination. Where water supplies for municipal purposes are to be obtained from near-surface limestone or dolomite aquifers, at least 100 feet of glacial cover must overlie these aquifers. Where pollution is known to exist in the aquifers, chlorination treatment is necessary, regardless of the thickness of drift cover.

For adequate protection in sparsely populated areas, a minimum thickness of 30

feet of clayey glacial till is necessary between the lowest point of potential sources of pollution (such as privy vaults, cesspools, tile in seepage systems, excavations, and abandoned wells) and the top of the limestone or dolomite within a radius of one-fourth of a mile from the well. The installation of leaching types of private waste-disposal facilities are not recommended where less than 30 feet of clayey glacial till is present between the surface of the limestone or dolomite and the lowest point of the source of pollution.

Because polluting bacteria tend to float on or near the top of the zone of saturation, the injection of cement grout between the casing and the limestone or dolomite from the surface to at least 15 feet below the maximum drawdown level, may, along with continuous adequate chlorination of the water supply, provide adequate protection.

In Winnebago County there are extensive areas within which the dolomite aquifers of Ordovician age are overlain by less than 50 feet of glacial cover (fig. 8). The glacial deposits overlying the dolomites consist largely of till of Farmdale age that has a matrix characterized by low clay content and is classified as a silty sand. Such material is likely to have a higher than average permeability for glacial till and to require greater thickness for effective filtration of polluting bacteria. Locally, the thin glacial cover may contain only highly permeable sand and gravel deposits that afford little protection from movement of bacterial pollution into the underlying dolomite aquifers.

Sandstone Aquifers

In Winnebago County the basal rocks of Ordovician age, including the St. Peter Sandstone and the lower part of the Glenwood Formation, form a geohydrologic unit that is widely used as a source of ground water. This unit is characterized by permeable, relatively uniform lithology and is continuous throughout most of the area. The shales and dolomites of the upper part of the Glenwood Formation are not known to be water-yielding in Winnebago County and, where present, separate the sandstone aquifers from the overlying dolomite aquifers.

The sandstone aquifers are believed to underlie the entire county, with the exception of the extreme northern part of the ancient Rock Valley (fig. 10) where the base of the valley probably penetrates the underlying Trempealeau Dolomite. Throughout most of the county stock and domestic wells can be developed economically within the upper 50 feet of the unit.

Unlike the overlying dolomite aquifers, the sandstone aquifers satisfactorily supply enough water for smaller municipalities, subdivisions, public institutions, parks, and several industries that have water requirements generally less than 300 gpm. Of the total number of well records used in this study, 71 were of wells that obtained water principally or entirely from the sandstone aquifers of Ordovician age.

In Winnebago County the sandstone aquifers are for the most part overlain by dolomites of the Galena, Decorah, and Platteville Formations or by relatively thick deposits of glacial drift (fig. 10) and the water in the sandstone aquifers is generally artesian. Water-table conditions occur in the sandstones only in the limited areas where they are exposed at land surface or are overlain by a thin cover of glacial deposits.

Along the Rock Valley north of Rockford, the hydrostatic pressure in the sandstone aquifers is somewhat greater than that in the overlying gravel (Smith and Larson, 1948, p. 18) and water from the sandstone aquifers is discharged into the glacial drift with which it is in contact. Within the Rockford area, pumpage from the sandstone aquifers has developed cones of depression within which hydrostatic pressure in the bedrock aquifers is less than that of the overlying glacial drift and local recharge of the sandstone aquifers from the overlying gravels apparently occurs (Smith and Larson, 1948, p. 18).

In the Pecatonica River Valley, discharge from the sandstone aquifers is retarded by the relatively tight valley fill. Locally, as at the Atwood Fish Farm, hydrostatic pres-

sure on the water in these sandstone aquifers is sufficient to cause flowing wells.

Cambrian Aquifers

The thick, extensive, and permeable formations of the Cambrian System form a geohydrologic unit that contains the principal bedrock aquifers for the development of large-capacity wells in Winnebago County. The principal water-yielding units of the Cambrian aquifers are the clean, well sorted sandstone beds of the Ironton-Galesville Sandstone; the clean, medium- to coarse-grained sandstone beds in the basal zone of the Eau Claire Formation; and the clean, better sorted, medium- to coarse-grained sandstone in the thick Mt. Simon Formation.

Because all these aquifers are used by most of the high-capacity bedrock wells in Winnebago County, and because insufficient geologic, hydrologic, and chemical data are available to distinguish between them, the Cambrian aquifers are considered as a geohydrologic unit in this report. In other parts of northern Illinois where more distinct differences in hydrologic character or water quality exist, the aquifers of the deeper lying basal Eau Claire and Mt. Simon Formations can be distinguished from the aquifers in the overlying Ironton-Galesville Sandstone (Thwaites, 1927, p. 35; Foster, 1956, p. 44; Suter et al., 1959, p. 40). In Winnebago County, however, available data and normal well construction methods do not warrant such a distinction, even though these two water-yielding zones generally are separated by approximately 250 feet of relatively impermeable shales and shaly and dolomitic sandstones of the middle and upper zones of the Eau Claire Formation.

The Cambrian aquifers are separated from the sandstone aquifers of Ordovician age by dolomites, shales, and dense, fine-grained sandstones of the Trempealeau and Franconia Formations, the combined thickness of which ranges from about 75 feet to nearly 200 feet in the county. The generally fine-textured deposits of the Franconia Formation are presumed to be essentially non-water-yielding. There is some indication that the Trempealeau Dolomite may locally yield water. Drillers have reported fractures and openings in the Trempealeau Dolomite. A relatively high coefficient of transmissibility, about 350,000, was obtained by the pumping test of a well at the George D. Roper Corporation and may possibly have been caused by the influence of a water-yielding crevice in the Trempealeau Dolomite (Smith and Larson, 1948, p. 17). There is no record of a well that obtains water supplies solely from the Trempealeau Dolomite in Winnebago County.

The Cambrian aquifers are used only for larger municipal and industrial water supplies because their depth results in high construction and maintenance costs and because dependable aquifers generally are present at shallower depths. Although the number of wells drilled to the Cambrian aquifers in Winnebago County is relatively small, the proportionate quantity of ground water supplied by these aquifers probably is greater than that of any of the other geohydrologic units in the county. Only the thick glacial drift aquifers are comparable sources of large water supplies.

The depths of the wells to the Cambrian aquifers range from about 400 to about 2000 feet and commonly are from 700 to 1600 feet deep. The wells generally are uncased in the bedrock formations and water is contributed from the shallow as well as the deep aquifers. No water wells have penetrated the entire thickness of the Mt. Simon Sandstone. At Rockford between 900 and 1000 feet of strata composed principally of medium- to coarse-textured sandstone and conglomerates are estimated to lie beneath the depth reached by the deepest wells. Although the water-yielding potential of these deep deposits is possibly very large, no specific information is available regarding their hydrologic character, temperature, or quality of the water they contain.

Ground water in the Cambrian aquifers is under artesian conditions because of their depth below land surface, and because they are everywhere overlain by less permeable deposits. The city of Rockford

drilled the first well to the Cambrian aquifers in 1885. It was drilled to a depth of 1530 feet and a flowing well was obtained with a head approximately 33 feet above a land-surface elevation of about 712 feet (Anderson, 1919, p. 228). By 1919 the static head in the Cambrian aquifers had declined about 38 feet, but was still 10 to 20 feet higher than that in the St. Peter Sandstone (Anderson, 1919, p. 226, 227).

In their study of the ground-water resources of Winnebago County, Smith and Larson (1948, p. 14) were able to detect little if any difference in the water levels of the various sandstones. Since 1885 there has been a general increase in the quantity of water produced in the Rockford area from both Ordovician and Cambrian aquifers (Smith and Larson, 1948, p. 13). The number of wells drilled to the deeper sandstones which have been uncased opposite the shallower bedrock aquifers also has increased. As a result, an equalization of temperature and pressure differences between the Cambrian and Ordovician bedrock aquifers in and surrounding the area of development probably has taken place. In areas where the deeper Cambrian aquifers are undeveloped there may be significant differences in hydrostatic head between them and the shallower bedrock aquifers.

Only in the Rockford area has there been a concentrated withdrawal of water from the Cambrian aquifers. There, hydrologic investigations indicate that much of the ground water now naturally discharged into the streams would become available as the hydrostatic pressures on the water in the bedrock aquifers is lowered by ground-water withdrawal (Smith and Larson, 1948, p. 2, 21). In addition, there is a considerable thickness of probably permeable deposits of the Mt. Simon Sandstone beneath the deepest wells penetrating the Cambrian aquifers at Rockford. These deeper deposits could support large-capacity wells if they are found to contain water of suitable temperature and quality.

In the rest of Winnebago County the thick, widespread Cambrian aquifers are largely undeveloped. The ground-water resource potential of these aquifers is large, particularly in areas where local recharge from surface streams and permeable Pleistocene aquifers may become available as the aquifers are developed.

CONCLUSIONS

Several conclusions may be drawn from this study of the ground-water geology of Winnebago County.

1. The principal aquifers are grouped into four geohydrologic units that include a) Pleistocene aquifers, b) dolomite aquifers of Ordovician age, c) sandstone aquifers of Ordovician age, and d) Cambrian aquifers.

2. The principal bedrock sources of water for industrial and municipal uses are the Cambrian aquifers. The most favorable water-yielding formations of the Cambrian aquifers are the Ironton-Galesville Sandstone, the sandstone beds of the basal part of the Eau Claire Formation, and the Mt. Simon Sandstone. Throughout most of the county these permeable bedrock aquifers are undeveloped and constitute a large ground-water resource potential. At Rockford the Cambrian aquifers have been penetrated by large-capacity wells to a maximum depth of about 2000 feet and probably are underlain by several hundred feet of chiefly coarse-textured and permeable sandstones and conglomerates. Data on the temperature and quality of the water in the basal part of the Mt. Simon Sandstone and more detail regarding the character and sorting of these deeper sediments must be obtained before the ground-water potential of these deeper lying deposits can be adequately evaluated.

3. Although original differences in hydrostatic head between the Cambrian aquifers and the overlying Ordovician aquifers apparently are largely equalized in the Rockford area, differences in head probably occur where the Cambrian aquifers have not been developed. In most areas the head of the water in the Cambrian aquifers is probably greater than that of the water in the Ordovician aquifers, thus providing an inducement to the development of water supplies from the deeper aquifers.

4. The principal source of water for domestic, farm, and other private water supplies is the dolomite aquifers of Ordovician age. The dolomite aquifers are a consistent and dependable source of water because of an extensive joint and fracture system. Most wells drilled for small water supplies into these Ordovician aquifers penetrate between 20 and 100 feet into the dolomite.

In much of the county the dolomite aquifers are near land surface and are overlain by less than 50 feet of glacial cover. Here the water in the dolomite aquifers is susceptible to bacterial pollution, and adequate precautionary measures, such as those suggested by the State Department of Public Health, should be followed. In most instances protection from polluted water supplies can be obtained by proper well construction and chlorination or by the drilling of wells to deeper aquifers.

5. The thick deposits of coarse-textured, valley-train sands and gravels that occur as fill in the major preglacial valleys that served as through-drainage ways for glacial meltwaters have a high permeability and are favorable aquifers for the development of large supplies of water for municipal and industrial uses.

The buried Rock Valley contains the most extensive and permeable glacial drift aquifers in the county. Throughout a large part of the Rock Valley, valley-train deposits are more than 100 feet thick and consist chiefly of coarse-textured sand and gravel.

Considerable thicknesses of permeable outwash may occur in the deeper part of the fill in the buried Troy Valley in the southeastern corner of the county, but the texture, thickness, and water-bearing properties of the outwash are unknown.

In the Pecatonica and Sugar River Valleys and their tributaries the valley fill probably contains a large proportion of fine-textured deposits and they are, therefore, probably less satisfactory areas for the development of large-capacity wells than is the Rock Valley or the Troy Valley. Some coarse-textured outwash is found in these valleys, but the extent, distribution, and water-yielding character of glacial drift aquifers is unknown. Fine-textured sediments in the upper part of the fill of these valleys probably would prevent rapid ground-water recharge from precipitation and surface streams in areas where deeper lying, coarser textured aquifers can be developed.

6. The deep drift-filled valleys consist of a more or less central V-shaped channel, 150 to 250 feet deep, cut into a wider bench or strath surface. This surface, which may occupy a sizeable part of the valley area, is in turn bounded by the present valley walls and generally is buried beneath the valley fill. Because the storage capacity of the valleys is considerably less than would be calculated on the basis of a U-shaped valley, former interpretations that postulated a U-shaped profile for the bedrock valleys should not be applied in quantitative evaluations.

7. Future ground-water studies in the region should be organized to obtain further geologic, hydrologic, and water-quality data for the geohydrologic units in order to define better their water-bearing characteristics and occurrence.

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APPENDIX 1

LIST OF PRINCIPAL WELLS

Well no.	Well name	Use*	Date drilled	Elevation (topographic map)	Depth (feet)	Type of record*	Principal aquifer*
WIN 26N11E- 8.2a	Winnebago School	P.I.	1922	885	300	Drillers log	OS
- 9.8c1	Winnebago Village #2	Mun.	1949	810	810	S.S. 19386	C
-12.2h	Wildwood Burial Park	Priv.	1929	825	480	S.S. 855	OS
-34.2a	Harry Severson (Jeffrey Log Cabin)	Priv.	1941	820	323	S.S. 7161	OS
-35.7f	Harry Severson (Dells Farm)	Priv.	1941	850	355	S.S. 7160	OS
WIN 27N10E-28.8d1	Pecatonica city #1	Mun.	1936	760	660	Drillers log	C
-29.1d	Pecatonica city #2	Mun.	1946	785	750	S.S. 14395	C
-29.1g	Dean Milk Factory	Ind.	1915–1925	760	302	Drillers log	OS
WIN 27N11E- 6.1e	Atwood Fish Farm #3	Priv.	1952	730	305	Drillers log	OS
- 6.4e	Atwood Fish Farm #2	Priv.	1944	728	606	S.S. 11202	C
-16.2a	Burrit School	P.I.	1956	860	195	Drillers log	OD
WIN 28N10E-10.5b	Durand Village #1	Mun.	1920	772	180	Drillers log	OS
-10.8b	Durand Village #2	Mun.	1957	823	301	S.S. 30668	OS
-20.8f	L. H. Burrell	Priv.	1947	945	400	S.S. 17436	OS
WIN 28N11E-21.6a	Winnebago Co. Boys Reform School	P.I.	1941	800	283	S.S. 8452	OS
-27.1a	W. W. Barton	Priv.	1944	730	265	S.S. 18278	OS
-36.3f	William R. Stevens #2	Priv.	1950	810	295	S.S. 21075	OS
WIN 43N1E - 2.5g	Rock River School	P.I.	1931	730	130	S.S. 1157	Pl
- 2.5h	Kishwaukee Auto Parts	Ind.	1954	720	107	Drillers log	Pl
- 3.2f1	Central Ill. Gas & Electric Co. #1	Ind.	1948	700	354	S.S. 18070	OS
- 3.2f2	Central Ill. Gas & Electric Co. #2	Ind.	1953	710	825	S.S. 22941	C
- 3.3h	Rockford Wholesale Beef Co.	Ind.	1943	720	145	S.S. 18256	OD
-11.4b	Rock River Consolidated School #1	P.I.	1952	735	103	S.S. 22613	Pl
-13.5h	Lins Air Theater #2	Priv.	1954	785	152	Drillers log	OD
-20.1a	E. A. Barrett	Priv.	1920?	775	400	Drillers log	OS
-25.3f	Morris Trailer Camp	Priv.	unknown	755	324	Drillers log	OD
WIN 43N2E -5.5h	Starkey School District	P.I.	unknown	843	128	CWA log	OD
- 6.6a	Sandy Hollow Park	P.I.	1928	820	853	S.S. 819	C
-10.1g	Illinois Central R.R.	Ind.	1940	775	110	Drillers log	OD
-22.1d2	Unknown	Priv.	unknown	790	265	Field record	Pl
-28.4f	Camp Rotary	P.I.	1944	750	511	S.S. 11413	OS
WIN 44N1E - 1.7h	Winnebago County Farm #2	P.I.	1931	770	440	S.S. 1067	OS
- 2.3c	Rockford city unit #3	Mun.	1948	760	1127	S.S. 18072	C
- 9.1f	Winnebago County Home of the Aged	P.I.	1953	780	435	S.S. 23701	OS
- 9.1g	Whig Hill School	P.I.	1947	785	330	S.S. 17584	OS
-11.1b	W. F. and John Barnes Co.	Ind.	1941	745	1155	S.S. 7417	C

-11.1c	Atwood Vacuum Machine Co. #1	Ind.	1943	745	709	S.S. 10832	C
-11.2c	Atwood Vacuum Machine Co. #2	Ind.	1951	743	710	S.S. 21781	C
-11.3g	Halstead Subdivision	P.S.	unknown	750	234	Drillers log	OS
-12.7b	Ingersoll Milling Machine Co.	Ind.	1941	745	1204	S.S. 6644	C
-13.6d	Rockford City #8c	Mun.	1915	725	1500	S.S. 3	C
-14.1d	Auburn Amusement Co.	Ind.	1941	735	350	S.S. 8491	OS
-15.3c	Rockford Consolidated Dairy Co.	Ind.	1929–1930	725	1125	S.S. 965	C
-16.1e	Rockford Pepsi-Cola Co.	Ind.	1948	730	410	S.S. 18827	OS
-17.5c	Winnebago County Garage	P.I.	1938	795	353	S.S. 3171	OS
-17.6c	J. Florin, Dairy	Ind.	1931?	800	127	Drillers log	OD
-18.7d	Winnebago Television Corp.	Ind.	1953	790	250	S.S. 22926	OS
-20.6b	W. E. Dennis School	P.I.	1953	800	486	S.S. 23703	OS
-20.7f	Ingersoll Memorial Park	Priv.	1921	820	846	Drillers log	C
-21.3b	J. I. Case Co..	Ind.	1950	725	1200	S.S. 20291	C
-21.7f	G. S. Birks Nursery	Ind.	1927?	820	473	S.S. 647	OS
-22.1a	Burson Knitting Co.	Ind.	1908–1909	710	360	Drillers log	OS
-22.2b1	Allen Ice Cream Co.	Ind.	unknown	730	240	Field record	OD
-22.2b2	Allen Ice Cream Co.	Ind.	1948	735	400	S.S. 18745	OS
-22.3e	Roxo Ice Cream Co.	Ind.	unknown	715	130	Field record	OD
-22.3g	Hess & Hopkins Tannery	Ind.	1909	720	370	Drillers log	OS
-22.4d1	Chicago, Milwaukee, St. Paul & Pacific R.R.	Ind.	unknown	720	438	Drillers log	OS
-22.4d2	Rockford Gas, Light & Coke Co.	Ind.	1928	720	1200	S.S. 753	C
-22.5c1	Rockford city #2c	Mun.	1921–1926	729	1600	City files	C
-22.5c2	Rockford city #3c	Mun.	1921–1926	730	1600	City files	C
-22.5c3	Rockford city #4c	Mun.	1921–1926	730	1633	City files	C
-22.5c4	City of Rockford Test 1–53	T.H.	1953	730	83	S.S. 23303	—
-22.6c1	Rockford city #1c	Mun.	1921–1926	720	1600	City files	C
-22.6c2	Rockford city #5c	Mun.	1926	726	1605	S.S. 656	C
-22.6d	Rockford city #6c	Mun.	1926	732	1608	S.S. 657	C
-23.2b	City of Rockford Test 1–54	T.H.	1954	735	255	Drillers log	—
-23.6d1	Rockford city #3b	Mun.	1886	724	2001	Drillers log	C
-23.6d2	Rockford city #4b	Mun.	1887	708	1300	Eng. blueprint	C
-23.7c1	Rockford Trust Building	Ind.	1915	715	250	Eng. report	OS
-23.7c2	Palace Amusement Co.	Ind.	1941	720	325	S.S. 6404	OS
-23.8a	Rockford Mitten & Hosiery Co.	Ind.	unknown	710	255	Eng. report	OS
-23.8b	Silver Plate	Ind.	unknown	710	250	Eng. report	OS
-25.6g	Standard Dairy	Ind.	unknown	780	410	Co. engineer	OS
-25.7h	St. Anthony's Hospital	P.I.	1933	790	810	S.S. 1360	C
-26.1d	City of Rockford (T.H. 11)	Mun.	1950	720	267	S.S. 20471	Pl
-26.3d	Union Dairy Co.	Ind.	1915	720	300	Drillers log	OS
-26.7b	Rockford Paper Box Board Co.	Ind.	unknown	755	1225	Drillers log	C
-26.8b	Rockford Fiber Container (now occupied by Rockford Paint Mfg. Co.)	Ind.	unknown	720	225	Field record	OS
-26.8c	People's Crystal Ice Co.	Ind.	unknown	705	±100	Drillers log	OS

* Mun., Municipal; Ind., Industrial; P.I. Public institution; P.S., Public supply; Priv., Private; T.H., Test hole; S.S., Illinois State Geological Survey sample set; Pl., Pleistocene aquifers, O.D., Dolomite aquifers of Ordovician age; O.S., Sandstone aquifers of Ordovician age; C. Cambrian aquifers.

LIST OF PRINCIPAL WELLS — Continued

Well no.	Well name	Use*	Date drilled	Elevation (topographic map)	Depth (feet)	Type of record*	Principal aquifer*
WIN 44N1E -27.2b	Grahams Distillery	Ind.	unknown	710	250	Drillers log	OS
-27.2g	Woodward Governor Co.	Ind.	1938	700	291	Drillers log	OS
-27.1h	Love Manufacturing Co.	Ind.	unknown	700	150	Drillers log	OS
-27.2h	Rockford Brass Works	Ind.	1948	715	385	S.S. 18255	OS
-31.1a	Centerville School Dist. 72 #1	P.I.	1955	815	130	Drillers log	OD
-34.6h	Rockford City #4	Mun.	1948	740	1219	S.S. 18130	C
-35.1a1	Rockford Screw Products Co. Plant 1, well #1	Ind.	1937	730	555	S.S. 2288	OS
-35.1a2	Rockford Screw Products Co. Plant 1, well #2	Ind.	1943	730	454	Co. engineer	OS
-35.2a	Rockford Screw Products Co. Plant 1, well #3	Ind.	1949	730	475	S.S. 18843	OS
-35.2f	National Lock Co.	Ind.	1925	740	925	Drillers log	C
-35.5a	Rockford Screw Products Co. Plant 2, well #2	Ind.	1948	730	1060	S.S. 18093	C
-35.5d	Damascus Steel Products	Ind.	unknown	730	132	Field record	Pl
-35.6a	Rockford Screw Products Co. Plant 2, well #1	Ind.	unknown	725	398	Field record	OS
-35.6d	Mattison Steel Corp.	Ind.	1917	735	138	Field record	Pl
-35.7a	City of Rockford #14	Mun.	1957	700	255	S.S. 30001	Pl
-35.7b	Northwest Malleable Iron Corp.	Ind.	1928	730	1005	S.S. 815	C
-36.6d	Greenlee Bit and Tool Co.	Ind.	1913	735	743	Co. file	C
-36.6f	City of Rockford Water Dept. #7a	Mun.	1947	730	200	S.S. 30106	Pl
-36.7f	Rockford City Water Works #7	Mun.	1947	729.5	1503	Drillers log	C
WIN 44N2E - 6.4c	Loves Park test well.	Mun.	1952	730	203	S.S. 22731	Pl
- 6.5h	Harlem Cons. School Dist. #122	P.I.	1954	727	82	S.S. 27642	Pl
- 6.6h	Harlem Cons. School #1	P.I.	1952	727	100	S.S. 22612	Pl
- 6.8h	Meadow Mart Shopping Center	Priv.	1953	729	76	S.S. 23702	Pl
- 7.1a	E. A. Kuharsky	Priv.	unknown	815	210	Field record	Pl
- 7.4f	American Chicle	Ind.	1955	750	213	S.S. 25687	Pl
- 7.8e1	Woodward Governor basement well	Ind.	1941	725	1227	S.S. 23809	C
- 7.8e2	Woodward Governor east well, #3	Ind.	1943	725	732	S.S. 8546	C
-16.1a	Guilford Center School	P.I.	1954	865	165	S.S. 24871	OD
-17.7f	Edgebrook Farm	Priv.	1928	800	1210	Drillers log	C
-18.1b	Floyd Palm	Priv.	1946	835	308	S.S. 16117	OS
-18.2b	C. A. Barber	Priv.	1942	820	230	Drillers log	OD
-18.2h	Tolmie and Wolfley	Priv.	unknown	815	495	S.S. 914	OS
-18.4h	Bradley Heights subdivision	Mun.	1930	800	500	S.S. 966	OS
-18.7a	Rockford City #5	Mun.	1944	790	1312	S.S. 11440	C
-18.7b	Burr, Hughes subdivision	Mun.	unknown	780	627	Drillers log	OS
-19.6b1	City of Rockford Eastside #9c	Mun.	1928	807	1600	S.S. 786	C
-19.6b2	City of Rockford test well #2	T.H.	1953	810	250	S.S. 23304	Pl
-20.3e	Rockford city #13	Mun.	1955	842	1457	S.S. 26121	C
-21.7f	Mauh-Nah-Tee-See Country Club #1	Priv.	1928	845	305	S.S. 731	OD

	-21.8g	Mauh-Nah-Tee-See Country Club #2	Priv.	1928	795	300	S.S. 1268	OD
	-24.8g	Ivan A. Seele et al. #1	Oil well test	In progress	870	2689	S.S. 20109	—
	-29.3a	Rockford city #10	Mun.	1947	865	1426	S.S. 17731	C
	-31.7g	Rockford city #6	Mun.	1941	789	1376	S.S. 5507	C
WIN 45N1E	- 3.3a	School District #137	P.I.	1953	850	130	Drillers log	OD
	-12.8h	Canada School Dist.	P.I.	1900	830	117	Drillers log	OD
	-14.1b	C. E. Swanson	Priv.	1928	780	425	S.S. 730	OD
	-16.1a	Owen Center Church	P.I.	1944	820	78	S.S. 18257	OD
	-25.1b	North Park #1	Mun.	1956	732	195	S.S. 27079	Pl
WIN 45N2E	-11.4b	W. K. Young	Priv.	1944	900	257	Drillers log	OD
	-30.3a	Harlem Cons. School Dist. 122 #2	P.I.	1954	735	138	S.S. 27643	Pl
	-31.1g	North Park Water Service	Mun.	1954	735	168	S.S. 24430	Pl
WIN 46N1E	-13.2a	City of Rockton	Mun.	1956	760	120	S.S. 27475	Pl
	-13.4c	Fred Wieland	Priv.	1948	750	230	Drillers log	OS
	-24.8c	Rockton City #3	Mun.	1940	780	200	S.S. 4386	OS
WIN 46N2E	- 5.7d	Wisconsin Power & Light Co. #3	Ind.	1937	735	1190	S.S. 2417	C
	- 6.2b	Chicago, Milwaukee, St. Paul & Pacific R.R.	Ind.	1940	735	400	S.S. 4612	C
	-28.7h	Warner Electric Brake & Clutch Co. Plant 2	Ind.	1956	755	97	Drillers log	Pl

* Mun., Municipal; Ind., Industrial; P.I. Public institution; P.S., Public supply; Priv., Private; T.H., Test hole; S.S., Illinois State Geological Survey sample set; Pl., Pleistocene aquifers; O.D., Dolomite aquifers of Ordovician age; O.S., Sandstone aquifers of Ordovician age; C, Cambrian aquifers.

APPENDIX 2

REFERENCE WELLS

WIN 44N1E-2.3c. Rockford city unit 3. Drilled 1948 by Varner Well Drilling Company. Total depth 1127 feet. Elevation 760 feet, estimated from topographic map. Illinois State Geological Survey sample set 18072. Studied by M. P. Meyer.

	Thickness (*ft*)	*Depth* (*ft*)
Pleistocene Series		
No samples	25	25
Sand and gravel, very silty, yellow, calcareous	10	35
Till, yellowish gray, calcareous	30	65
Ordovician System		
Platteville Dolomite		
Dolomite, oxidized, yellow, very fine	15	80
Dolomite, partly argillaceous, light gray, gray mottled, partly oxidized, very fine to fine	30	110
Dolomite, partly argillaceous, gray mottled, very fine	15	125
Dolomite, buff, gray mottled, very fine to fine	20	145
Same, red speckled	10	155
Dolomite, sandy, buff, fine	2	157
Glenwood Formation		
Dolomite, silty to fine sandy, partly argillaceous, white to green, buff, sublithographic	8	165
Dolomite, as above; grading to sandstone	5	170
Sandstone, clay, silty, yellow, very fine to coarse, incoherent; dolomite, silty to very fine, sandy, oxidized, yellow, sublithographic; trace shale, sandy, green at base	20	190
St. Peter Sandstone		
Sandstone, silty, yellow, very fine to medium, incoherent	5	195
Sandstone, silty, yellow, a few red grains at top, very fine to coarse, some very coarse, incoherent	20	215
Sandstone, white, fine to coarse, incoherent	40	255
Sandstone, slightly silty, light yellow, very fine to coarse, incoherent	5	260
Sandstone, white, fine to coarse, incoherent	10	270
Same, few pieces, yellow, pink, friable	35	305
Sandstone, slightly silty, some yellow, very fine to coarse, incoherent	20	325
Sandstone, light yellow, fine to coarse, incoherent	5	330
Sandstone, pink, fine to medium, incoherent	20	350
No sample	5	355
Sandstone, white, medium to coarse, mostly incoherent, some siliceous cement, yellow, compact	10	365
Sandstone, slightly silty, fine to coarse, mostly incoherent, some siliceous cement, yellow, red, compact	25	390
Sandstone, siliceous, yellow and pink mottled, compact	5	395
Sandstone, silty, red, very fine to coarse, incoherent; sandstone, siliceous, red, yellow, compact; chert and quartz	5	400
Chert, white, partly quartzitic	5	405
Chert, as above; siltstone, siliceous, red, yellow, compact; trace shale, red at top	20	425
Sandstone, slightly silty, pink, very fine to coarse, incoherent, some siliceous cement, white; chert, white, partly oolitic; trace clay, white, red	5	430
Cambrian System		
Trempealeau Dolomite		
Dolomite, some glauconitic, buff, slightly pink mottled, very fine	20	450
Dolomite, glauconitic, partly silty, cherty, light buff, very fine	15	465
Dolomite, glauconitic, partly silty, light buff, pink mottled at top, very fine, quartz	10	475
Dolomite, glauconitic, silty, light buff to light green, very fine	15	490
Dolomitic, glauconitic, sandy (very fine), light buff, slightly pink mottled, very fine; grading to some sandstone, glauconitic, dolomitic, very fine, light green, compact	15	505
Franconia Formation		
Shale, silty, sandy, red, some green, weak; sandstone, silty, dolomitic, glauconitic, green, red; some dolomite, argillaceous, red	10	515
Shale, very silty and sandy, glauconitic, red, green streaked, weak	55	570
Sandstone, very argillaceous, silty, white, green spots, very fine to fine, incoherent	5	575
Sandstone, very argillaceous, silty, dolomite, slightly glauconitic, red, very fine to coarse, incoherent	15	590
Ironton-Galesville Sandstone		
Sandstone, silty, pinkish white, very fine to very coarse, incoherent	20	610
Sandstone, very dolomitic, red, very fine to medium, pseudo-oolitic, compact	10	620

	Thickness (ft)	*Depth (ft)*
Sandstone, silty, mostly dolomitic (red) pink, very fine to very coarse, incoherent to compact; trace shale partings, sandy, green	11	631
Sandstone, silty, pink, very fine to very coarse, incoherent	34	665
Sandstone, silty, white, very fine to coarse, incoherent	40	705
Sandstone, silty, white, very fine to fine, incoherent, dolomitic streak, white, red	5	710
Eau Claire Formation		
(Upper zone)		
Shale, silty, red, weak; some siltstone, red, compact	5	715
Shale, silty, green, weak; some siltstone, dolomitic, green, compact	5	720
Shale, silty, green, red streaked, weak; some siltstone, dolomitic, red, green, compact	10	730
Shale, silty, green, weak; some siltstone, dolomitic, yellow, compact	5	735
Shale, silty, red, micaceous, weak; some siltstone, dolomitic, glauconitic, red, compact	15	750
Same, green streaked	10	760
Siltstone, glauconitic, slightly dolomitic, slightly argillaceous, green, yellow; shale, very silty, light green; shale, very silty, buff at base	30	790
Shale, silty, green, micaceous, weak; some siltstone, dolomitic, compact	10	800
Shale, silty to fine sandy, green, red, mottled, very weak	5	805
Shale, silty, green, weak; some siltstone, glauconitic, dolomitic, green	20	825
(Middle zone)		
Sandstone, dolomitic streak, slightly silty, white, very fine to coarse, incoherent	10	835
Sandstone, argillaceous and very silty, light gray, pink at top, very fine to coarse, incoherent	15	850
Sandstone, silty, dolomitic streaks, light gray, fine to coarse, incoherent	10	860
Shale, very silty and sandy, light buff, very weak	5	865
Sandstone, silty, buff, very fine to coarse, incoherent	35	900
Sandstone, slightly silty, yellow (iron stained), fine to coarse, incoherent	20	920
Sandstone, silty, dolomitic streaks (light gray), buff, very fine to medium, incoherent	10	930
Sandstone, dolomitic streak (white), yellow, fine to coarse, incoherent	5	935
Sandstone, silty, dolomitic streaks (buff), light yellow, very fine to coarse, incoherent	15	950
Sandstone, slightly silty, light yellow, very fine to coarse, incoherent	25	975
Sandstone, slightly silty, dolomitic streak (white), fine to coarse, incoherent; trace shale partings, green, sandy	10	985
(Basal zone)		
Sandstone, slightly silty, yellow, fine to coarse, incoherent	10	995
Same, fine to coarse, some very coarse, some "sooty" grains	5	1000
Sandstone, slightly silty, yellow, fine to very coarse, incoherent	15	1015
Sandstone, yellow, medium to very coarse, incoherent	25	1040
Sandstone, silty, yellow, very fine to coarse, incoherent	10	1050
Sandstone, light yellow, fine to very coarse, incoherent	15	1065
Sandstone, white, medium to coarse, incoherent	30	1095
Sandstone, light yellow, fine to coarse, some "sooty" grains, incoherent; little shale, sandy, gray, flaky; trace siltstone, sandy, weak	10	1105
Sandstone, light gray, fine to coarse, incoherent, "sooty"	10	1115
Sandstone, yellow, fine to coarse, incoherent, some "sooty" grains	5	1120
Sandstone, yellow, fine to coarse, incoherent, some "sooty" grains, some sandstone, white, very fine, medium to coarse, friable	2	1122
Mt. Simon Sandstone		
Sandstone, yellow, medium to very coarse	3	1125
Shale, silty, red and green mottled (out of place)	2	1127

WIN 44N1E-35.7a. City of Rockford well 14. Drilled August 1957 by Layne-Western Company. Total depth 255 feet. Elevation 720 feet, estimated from topographic map. Illinois State Geological Survey sample study set 30001. Studied by J. E. Hackett.

Pleistocene Series		
Wisconsin Stage		
No sample	20	20
Sand, gray, medium to coarse, angular to subrounded; gravel, fine to medium, calcareous	10	30
Gravel, fine to coarse, subrounded to subangular, clean, sandy, calcareous	5	35
Sand, gray, some pink quartz grains, medium to coarse, gravelly, clean, calcareous	5	40
Gravel, fine to coarse, subangular to subrounded, clean, calcareous	5	45

	Thickness (ft)	Depth (ft)
Sand, gray, some pink quartz grains, fine to very coarse, mostly coarse, angular to subrounded, gravelly, clean, calcareous	15	60
Gravel, fine to medium, subrounded; coarse sand, clean, calcareous	5	65
Sand, gray, coarse, angular to subrounded; fine gravel, clean, calcareous	5	70
Gravel, fine to medium, subangular to subrounded; coarse sand, clean, calcareous	20	90
Sand, pinkish gray to gray, fine to coarse, angular to subrounded; gravelly at 90 to 95 and 105 to 110 feet, some pink silt at 100 to 105 feet, calcareous	20	110
Sand, gray to yellow, oxidized, fine to coarse, rounded to subangular, clean, gravelly, calcareous	5	115
Gravel, fine to medium, mostly fine, subrounded to subangular, very sandy, calcareous	5	120
Till? yellowish brown, oxidized, to pinkish gray to dark gray, very silty at top, becoming very clayey at base, sandy, gravelly, calcareous	10	130
Silt, brownish gray, sandy, calcareous	5	135
Silt and clay, light to dark gray, laminated, wood fragments, calcareous	5	140
Silt, very fine sand and clay interbedded, light to dark gray, calcareous	5	145
Sand, gray, fine to medium, becoming coarse at bottom, subangular to rounded, clean, calcareous	20	165
Sand, gray, coarse, angular to subrounded, many yellow oxidized grains, gravelly, silty at base, calcareous	10	175
Sand, gray, fine to very coarse, angular to subrounded, gravelly, clean, calcareous	35	210
Gravel, fine to coarse, angular to subrounded, silty from 200 to 235 feet, very sandy from 230 to 235 feet, calcareous	25	235
Pre-Wisconsin? alluvium		
Silt, yellow-green to gray, noncalcareous, some fine gravel, quartz and chert pebbles; sand, light gray, fine to medium, mostly quartz grains, some basic igneous grains, noncalcareous	5	240
Sand, light gray, fine, very silty; silt, greenish gray, noncalcareous	5	245
Sand, light gray, fine, mostly quartz and chert grains, very silty at top, becoming less silty at bottom, slightly calcareous	10	255

WIN 44N2E-18.4h. Bradley Heights subdivision well. Drilled 1930 by P. E. Millis and Company. Total depth 500 feet. Elevation 800 feet, estimated from topographic map. Illinois State Geological Survey sample set 966. Studied by L. E. Workman.

	Thickness (ft)	Depth (ft)
Pleistocene Series		
Till, sandy and pebbly, buff, weathered	15	15
Gravel, dolomitic, weathered, coarse, clayey	15	30
Gravel, dolomitic, clayey, yellow, fine to medium	35	65
Gravel, sandy, dolomitic, brownish yellow, fine to medium	20	85
Sand, dolomitic, slightly clayey, brownish yellow, coarse	20	105
Clay, dolomitic, silty, brownish gray	20	125
Sand, dolomitic, clayey, brownish gray, medium	15	140
Clay, dolomitic, silty, brownish gray	25	165
Sand, dolomitic, gray, fine, grading down to coarse	20	185
Gravel, dolomitic, gray, fine, grading down to medium	25	210
Clay, dolomitic, silty, brownish gray	10	220
Gravel, dolomitic, sandy, fine, yellowish gray	15	235
Sand, dolomitic, yellowish gray to pink, coarse	15	250
Sand, dolomitic, yellow, coarse, grading down to fine gravel	10	260
Gravel, dolomitic, yellow, fine	10	270
Gravel, slightly dolomitic, sandy, pink, fine	5	275
Clay, dolomitic, brownish gray	5	280
Till, dolomitic, gravelly, brownish gray	10	290
Till, dolomitic, pebbly, gray	35	325
Sand, dolomitic, grayish yellow, medium, mostly quartz and dolomite	2	327
Till, dolomitic, gray, slightly sandy	8	335
Sand, dolomitic, yellow, fine to medium	5	340
Ordovician System		
St. Peter Sandstone		
Sandstone, slightly dolomitic, yellow, fine, mostly incoherent	10	350
Sandstone, yellow, fine, incoherent	65	415
Sandstone, pink, fine, well sorted, incoherent	5	420
Sandstone, grayish yellow, fine to medium, incoherent	5	425
Sandstone, white, medium, poorly sorted, incoherent	5	430
Sandstone, silty, light yellow, fine, mealy	5	435
Sandstone, white, fine, incoherent	5	440
Sandstone, buff to pink, coarse to very fine, fair cementation with silica	35	475
Chert, sandy, red and brown brick color; chert, slightly oolitic, white and light gray, dense	15	490

	Thickness (ft)	Depth (ft)
Sandstone, clayey, reddish brown, coarse; chert, oolitic, light gray to white; chert, sandy, red	5	495
Sandstone, light gray, medium, much secondary quartz; chert, white, oolitic; chert, sandy, red	5	500

WIN 44N2E-24.8g. Ivan A. Seele et al. oil test well 1. Depth 2780 feet, drilling in progress. Elevation 820 feet, estimated from topographic map. Illinois State Geological Survey sample set 20109. Studied by P. M. Busch, J. W. Baxter, G. H. Emrich, and T. W. Smoot.

	Thickness (ft)	Depth (ft)
Pleistocene Series		
Sand and gravel to ¼ inch, yellow	15	15
Gravel to ½ inch and some sand, gray, clean	10	25
Sand and gravel to ¼ inch, yellow	10	35
Gravel to 1 inch, gray, clean	10	45
Gravel to ¼ inch and some sand, gray	10	55
Sand and fine gravel, gray, clean	7	62
Ordovician System		
Galena Dolomite		
Dolomite, yellow, fine to coarse, slightly porous	38	100
Dolomite, slightly cherty, light buff, fine to medium	10	110
Dolomite, yellow to light yellowish gray, fine to coarse, slightly porous	60	170
Dolomite, cherty at base, light grayish buff, fine to coarse, partly porous	28	198
Decorah Formation		
Dolomite, light yellowish gray, fine to coarse, dark speckled, partly porous	20	218
Platteville Dolomite		
Dolomite, slightly cherty, light yellowish gray, fine; few gray shale partings	16	234
Dolomite, light yellowish brown, fine to medium, slightly porous; few brown shale partings	34	268
Dolomite, light yellowish gray to gray to dark gray, fine, slightly pyritic	39	307
Dolomite, light yellowish brown, fine, gray streaks, sandy at base	24	331
Glenwood Formation		
Dolomite, sandy, silty, argillaceous, light gray to grayish green; some sandstone, white, fine to coarse, incoherent at base; some shale, grayish brown, firm	19	350
St. Peter Sandstone		
Sandstone, white, fine to coarse, incoherent	70	420
Sandstone, silty, white, fine to coarse, incoherent	14	434
Sandstone, white, fine to coarse, incoherent (stained yellow at 480 to 490 feet)	61	495
Sandstone, partly silty, white, very fine to coarse, incoherent	20	515
Sandstone, silty, white, very fine to medium, some coarse, incoherent	10	525
Sandstone, silty, white, very fine to medium, incoherent; some shale, silty, sandy, light gray to buff, weak	5	530
Sandstone, silty, white, very fine to medium, incoherent	5	535
Sandstone, white, very fine to coarse, incoherent, silty at base	10	545
Sandstone, white, fine to coarse, incoherent	15	560
Sandstone, silty, white, very fine to medium, incoherent	10	570
Sandstone, white, fine to coarse, incoherent; shale, sandy, reddish brown, tough	5	575
Sandstone, silty, white, fine to coarse, incoherent	10	585
Sandstone, white, fine to coarse, incoherent; shale, sandy, siliceous, pink to yellowish brown, yellow, tough	5	590
Chert, partly oolitic, white, dense	5	595
Conglomerate; chert, white, dense; shale, sandy, pink, reddish brown, yellow, tough; sandstone, silty, siliceous, white to pink, fine to coarse, incoherent to compact	15	610
Sandstone, silty, pink, fine, compact, some white, siliceous; some chert, white, dense; some shale, sandy, silty	5	615
Cambrian System		
Trempealeau Dolomite		
Dolomite, glauconitic, light yellowish gray to light yellowish brown, pinkish tint, fine; some quartz	25	640
Dolomite, glauconitic, slightly cherty, pale yellowish brown, pink and green, fine	5	645
Dolomite, glauconitic, pale yellowish brown, pink and green, fine	5	650
Franconia Formation		
Sandstone, glauconitic, dolomitic, yellowish gray, some pink and green, fine, compact	10	660
Sandstone, glauconitic, dolomitic, yellowish gray, some pink and green, fine, compact; some dolomite, sandy, pinkish, fine; trace shale, light green, weak	10	670
Dolomite, glauconitic, sandy, pink, fine	10	680
Sandstone, glauconitic, argillaceous, silty, dolomitic, slightly micaceous, red, fine	10	690
Shale, glauconitic, sandy, silty, dolomitic, red, some light green, weak	25	715
Sandstone, glauconitic, argillaceous, silty, dolomitic, slightly micaceous, red, fine; shale, as above	25	740

	Thickness (ft)	Depth (ft)
Sandstone, glauconitic, silty, greenish gray, very fine to coarse, incoherent; some shale, sandy, dolomitic, green to red, weak	5	745
Ironton-Galesville Sandstone		
Sandstone, partly dolomitic, white, some pink, very fine to very coarse, incoherent to compact	40	785
Sandstone, dolomitic, white to pink, fine to coarse, incoherent to compact	5	790
Sandstone, white, very fine to coarse, some very coarse, incoherent	20	810
Sandstone, partly dolomitic, white, some pink, medium to coarse, incoherent	5	815
Sandstone, white, fine to medium, some coarse, incoherent; some dolomite, light yellowish gray, fine; trace glauconite	78	893
Eau Claire Formation		
Shale, red, some green, weak; sandstone, argillaceous, red, yellow, fine, compact	7	900
Shale, silty, greenish gray, weak; shale, red, weak; sandstone, argillaceous, red, yellow, gray, compact	15	915
Sandstone, glauconitic, argillaceous, dolomitic, slightly micaceous, yellow, fine, compact; shale, dolomitic, red, green	10	925
Shale, silty, slightly micaceous, red, some green, weak	5	930
Sandstone, glauconitic, argillaceous, dolomitic, slightly micaceous, yellow, green, red, fine, compact; little shale, sandy, green and red	10	940
Shale, dolomitic, silty, greenish gray, weak	10	950
Shale, dolomitic, glauconitic, silty, grayish green, weak; some sandstone, dolomitic, glauconitic, light yellowish orange, fine, compact	20	970
No samples	90	1060
Sandstone, gray, very fine to coarse, incoherent; dolomite at base, sandy, pale yellowish brown, fine to coarse	22	1082
Dolomite, sandy, partly glauconitic and argillaceous, gray, fine to coarse	16	1098
Sandstone, silty, gray, very fine to coarse, incoherent	80	1178
Sandstone, gray, fine to medium, incoherent	7	1185
Sandstone, silty, yellowish gray, very fine to coarse, incoherent	39	1224
Sandstone, silty, moderate gray, fine to coarse, some very coarse, incoherent, "sooty"	8	1232
Sandstone, moderate gray, fine to coarse, medium at top, incoherent, "sooty"	13	1245
Sandstone, silty, moderate gray, fine to very coarse, incoherent, "sooty"	6	1251
Mt. Simon Sandstone		
Sandstone, silty, argillaceous, moderate yellowish gray, fine to coarse, some very fine and very coarse, incoherent	39	1290
Sandstone, silty, argillaceous, moderate yellowish gray, very fine to medium, some very coarse, incoherent	30	1320
Sandstone, silty, argillaceous, pale pink to yellowish gray, very fine to medium, some very coarse, incoherent	10	1330
Sandstone, partly silty, pink to light yellowish pink, fine to medium, some very coarse, incoherent; some shale, sandy, pink, yellowish brown, weak	18	1348
Sandstone, light yellowish gray, pink tint, fine to medium, some coarse and very coarse, incoherent	7	1355
Sandstone, silty, slightly argillaceous to argillaceous, pale yellowish pink, very fine to very coarse, incoherent	23	1378
Sandstone, silty, argillaceous, grayish yellow, very fine to very coarse, incoherent	7	1385
Sandstone, silty, argillaceous, dark pink, very fine to very coarse, incoherent, angular; some shale at base, sandy, micaceous, dark reddish pink, weak	23	1408
Sandstone, silty, argillaceous, dark reddish pink, fine to medium, some coarse and very coarse, incoherent	47	1455
Sandstone, pale grayish pink, fine to coarse, incoherent	5	1460
Shale, silty, sandy, dark reddish pink, weak	5	1465
Sandstone, silty, pale grayish pink, fine to medium, some coarse, incoherent	5	1470
Sandstone, silty, argillaceous, dark reddish pink, fine to coarse, incoherent	5	1475
Sandstone, silty, argillaceous, grayish pink, fine to coarse, incoherent; sandstone, silty, pale pink, fine to very coarse, incoherent; shale at base, dark reddish pink, weak	5	1480
Shale, sandy, dark reddish pink, weak	6	1486
Sandstone, grayish pink, fine to very coarse, incoherent	4	1490
Sandstone, silty, argillaceous, grayish pink, very fine to coarse, some very coarse, incoherent	7	1497
Shale, sandy, micaceous, dark reddish pink, some gray, weak	3	1500

	Thickness (*ft*)	*Depth* (*ft*)
Sandstone, silty, argillaceous, dark pink, very fine to coarse, some very coarse, incoherent; some shale, dark reddish pink, weak	35	1535
Sandstone, silty, argillaceous, grayish pink, very fine to medium, incoherent	15	1550
No samples	47	1597
Sandstone, silty, argillaceous, grayish pink, very fine to medium, incoherent	13	1610
Sandstone, silty, argillaceous, dark reddish pink, fine to very coarse, incoherent	15	1625
Sandstone, silty, argillaceous, pink, very fine to very coarse, incoherent	30	1655
Sandstone, silty, argillaceous, pink, medium to very coarse, incoherent	17	1672
Sandstone, silty, argillaceous, pink, fine to very coarse; some shale, sandy, dark reddish pink, weak	88	1760
Sandstone, grayish pink, fine to very coarse, incoherent . . .	25	1875
Sandstone, silty and argillaceous at top, pink to dark pink, fine to very coarse, incoherent . .	15	1800
Sandstone, silty and argillaceous to slightly silty argillaceous, pink, fine to coarse, incoherent	15	1815
Sandstone, slightly silty and argillaceous to silty and argillaceous, grayish pink, very fine to coarse, incoherent . . .	13	1828
Sandstone, dark pink, medium to very coarse, incoherent . . .	12	1840
Sandstone, grayish pink, fine to very coarse, incoherent . . .	8	1848
Sandstone, grayish pink, fine to medium, incoherent	32	1880
Sandstone, slightly silty, pink, fine to medium, incoherent . .	20	1900
Sandstone, pink, very fine to very coarse, incoherent	20	1920
Sandstone, pink, fine to medium, incoherent	15	1935
Sandstone, slightly silty, pink, very fine to very coarse, incoherent	10	1945
Sandstone, grayish pink, fine to very coarse, incoherent . . .	30	1975
Sandstone, grayish pink, fine to coarse, incoherent	10	1985
Sandstone, pale orangish gray, fine to very coarse, mostly fine to coarse, incoherent	24	2009
Sandstone, pink, fine to very coarse, incoherent	16	2025
Sandstone, slightly silty, pink, very fine to coarse, incoherent, silty at base	53	2078
Sandstone, grayish orange, very fine to very coarse, incoherent, ferruginous coatings	57	2135
Sandstone, pink, fine to coarse, incoherent	5	2140
Sandstone, pale grayish orange, fine to medium, incoherent . .	40	2180
Sandstone, grayish orange, fine to medium, incoherent . . .	22	2202
Sandstone, grayish orange, fine to very coarse, incoherent . . .	9	2211
Sandstone, orangish gray, very fine to coarse, incoherent . .	23	2234
Sandstone, pinkish orange, very fine to fine, incoherent . . .	6	2240
Sandstone, orangish gray, fine to medium, very fine to fine at base	15	2255
Sandstone, pale orangish gray, fine to medium, incoherent . .	25	2280
Sandstone, pale orangish pink, fine to medium, incoherent . .	20	2300
Sandstone, slightly silty, pink, mostly very fine to coarse, some very fine to very coarse, incoherent, ferruginous coatings. .	72	2372
Sandstone, silty to very silty, argillaceous, moderately reddish brown, fine to coarse, incoherent	18	2390
Sandstone, silty, pinkish orange to moderate reddish brown, very fine to medium, mostly very fine to fine, incoherent . . .	30	2420
Sandstone, silty, pinkish orange, very fine to coarse, incoherent .	16	2436
Sandstone, partly silty, pinkish orange, fine to coarse, incoherent	54	2490
Sandstone, pinkish orange, fine to coarse, mostly fine, incoherent .	38	2528
Sandstone, pale grayish pink, very fine to very coarse, mostly fine to medium, incoherent . .	14	2542
Sandstone, pink, very fine to coarse, mostly fine, incoherent .	20	2562
Sandstone, pink, very fine to coarse, incoherent	32	2594
Sandstone, pinkish gray, very fine to coarse, mostly coarse, incoherent, good proportion feldspar grains	3	2597
Sandstone, reddish orange, medium to coarse, much feldspar, some mica	8	2605
Sandstone, gray, medium to very coarse, incoherent; granite fragments, orangish red, feldspar, quartz, mica and ferromagnesian minerals (boulder?) .	5	2610
Sandstone, pinkish brown, fine to coarse, incoherent with feldspar and mica	30	2640
Sandstone, brown, mostly ground up, very fine to fine, but with a few coarse rounded grains, evidently hard, feldspar and mica .	9	2649
Sandstone, brown, very fine to fine, some medium to coarse, angular to subrounded, incoherent (samples ground up), feldspar (pink), mica (granite wash)	4	2653
Sandstone, brown, very fine to fine, trace of medium to coarse, angular to subrounded, incoherent, feldspar (pink), mica (granite wash)	2	2655

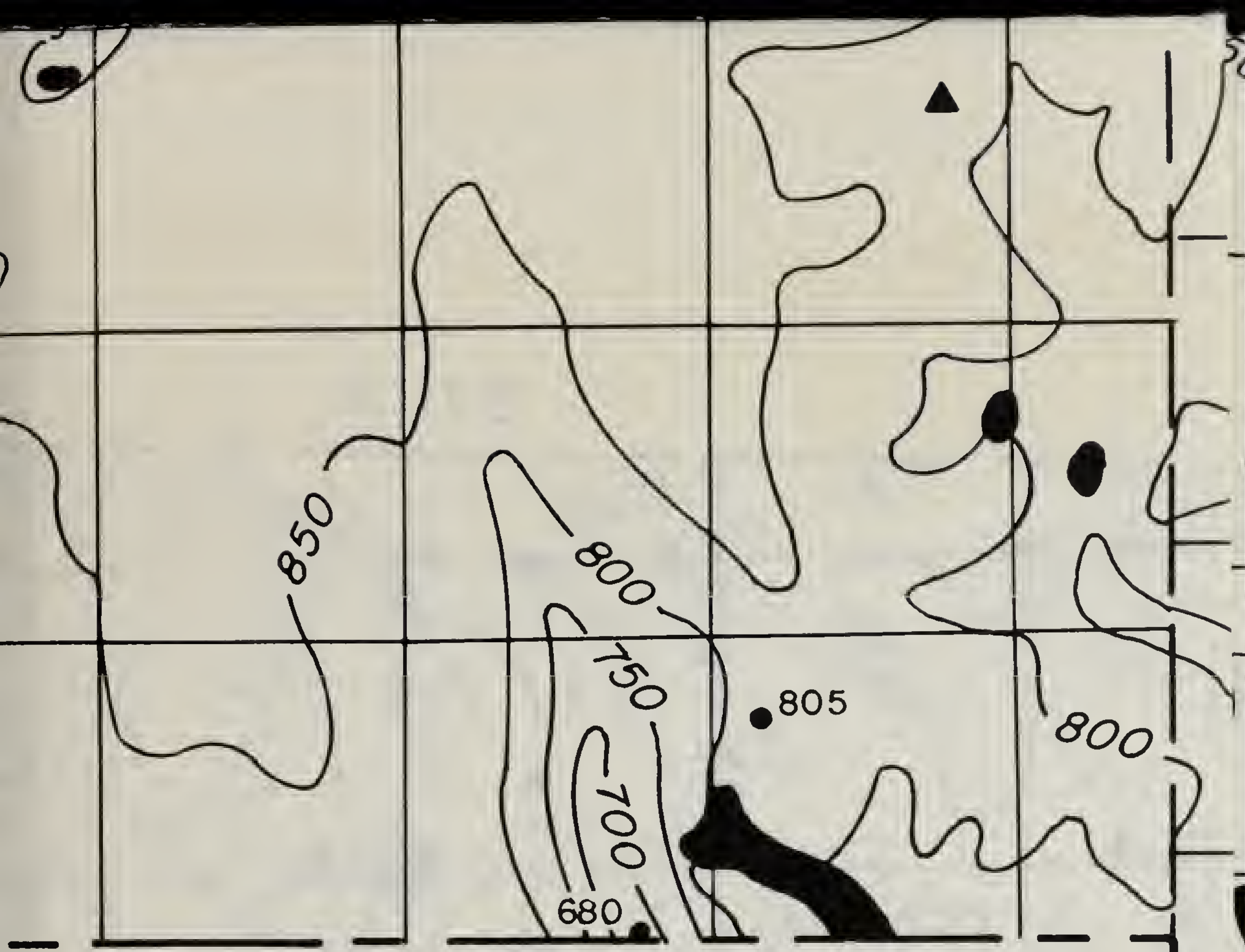
	Thickness (ft)	Depth (ft)
Sandstone, brown, very fine to medium, some coarse, angular to subrounded, incoherent; feldspar (pink), mica (granite wash)	1	2656
Precambrian		
Granite, micaceous, quartz, feldspar (pink)	31	2687
Contaminated sample, soil	½	2687½
No sample	12½	2700
Granite, as above	—	2700
Not studied	25	2725
Granite, approximately 50 to 60% feldspar, 30 to 40% quartz, 10 to 15% mica and hornblende (texture undeterminable)	55	2780

WIN 44N2E-31.7g. Rockford city well 6. Drilled 1941 by C. W. Varner. Total depth 1372 feet. Elevation 790 feet, estimated from topographic map. Illinois State Geological Survey sample set 5507. Studied by M. H. Smith and F. E. Tippie.

	Thickness (ft)	Depth (ft)
Pleistocene Series		
Till, sandy, gravelly, calcareous, brown, buff-brown	8	8
Gravel, dirty, fine, fairly well sorted	13	21
Gravel, sandy, dull, dirty, fine, rounded to angular, fairly well sorted	15	36
Gravel, sandy, dull, dirty, fine, rounded, well sorted	10	46
Gravel, clean, fine, rounded, well sorted	20	66
Gravel, dirty, sandy, dull, rounded to angular, fairly well sorted	5	71
Gravel, dull, fine to medium, rounded	5	76
Gravel, sandy, dirty, dull, fine, rounded, well sorted	10	86
Sand, light brown, fine to some medium, incoherent, angular	15	101
Gravel, slightly sandy, dull, granular	5	106
Gravel, sandy, shiny, clean, granular	3	109
Till, calcareous, gravelly, brown	17	126
Till, sandy, calcareous, gravelly, brown	25	151
Till, calcareous, sandy, brown	26	177
Ordovician System		
Platteville Dolomite		
Dolomite, silty, slightly argillaceous, light gray, dark gray, mottled, some speckled, fine	9	186
Dolomite, light gray, dark gray, mottled, partly spotted, sublithographic to fine	13	199
Dolomite, gray, dark gray, partly mottled, fine, partly slightly vesicular	17	216
Dolomite, sandy, light buff, light gray, very fine	5	221
Glenwood Formation		
Sandstone, dolomitic, buff to light gray, yellowish, very fine, coarse, compact; some dolomite	5	226
Dolomite, very finely sandy, light gray, greenish gray, sublithographic	20	246
Same, partly weathered, yellow; sandstone, dolomitic, light gray, yellow, very fine, medium, compact	5	251
St. Peter Sandstone		
Sandstone, white, very fine to coarse, incoherent	20	271
Sandstone, very silty, light buff, fine to coarse, incoherent	55	326
Sandstone as above, partly compact to friable	45	371
Sandstone, silty, light gray, fine to coarse, incoherent	10	381
Sandstone, light gray, very fine to coarse, incoherent	20	401
Sandstone, silty, light gray, fine to coarse, incoherent	25	426
Sandstone, silty, white, fine to coarse, crumbly to mostly incoherent	15	441
Sandstone as above, slightly cherty	5	446
Sandstone, cherty, silty, pink, fine to medium, partly cemented with chert to incoherent	15	461
Chert, white, some mottled pink, red, buff	5	466
Sandstone, silty, red, very fine to fine, compact, cemented with chert	5	471
Chert, oolitic, pink, some white	5	476
Sandstone, silty, pink, fine to coarse, incoherent; oolites, large, white, cemented with chert	5	481
Sandstone, cherty, pink, fine to coarse, compact, incoherent	5	486
Cambrian System		
Trempealeau Dolomite		
Dolomite, light buff, fine, partly vesicular	55	541
Dolomite as above with glauconitic specks	20	561
Dolomite, glauconitic specks, buff, pink, fine	20	581
Franconia Formation		
Sandstone, dolomitic, silty, glauconitic, light buff, very fine, compact	5	586
Sandstone, glauconitic, dolomitic, silty, micaceous, argillaceous, red, buff, very fine, friable	21	607
Shale, glauconitic, green, weak	4	611
Shale, glauconitic, red, green, pink, buff, weak	5	616
Shale, dolomitic, glauconitic, red, some green, weak	7	623
Sandstone, argillaceous, silty, glauconitic, very fine, compact	4	627
Sandstone, glauconitic, silty, brown, very fine, incoherent	14	641
Shale, sandy, dolomitic, cherty, brown, some red, weak	10	651
Shale, sandy, dolomitic, red, light gray, weak	5	656

	Thickness (*ft*)	*Depth* (*ft*)
Sandstone, glauconitic, silty, buff, some gray, very fine to fine, compact to some incoherent	10	666
Ironton-Galesville Sandstone		
Sandstone, silty, light buff, very fine to coarse, incoherent	5	671
Sandstone, partly dolomitic, silty, light buff, fine to coarse, compact to incoherent	5	676
Sandstone, partly dolomitic, silty, light buff, fine to coarse, incoherent to partly compact	30	706
Sandstone, silty, dolomitic, pink, light buff, fine to coarse, compact to partly incoherent	5	711
Sandstone as above, compact	5	716
Sandstone, silty, partly dolomitic, light gray, very fine to very coarse, incoherent to partly compact	5	721
Sandstone, silty, light gray, very fine to very coarse, incoherent	35	756
Sandstone, silty, white, fine to some medium, incoherent	55	811
Eau Claire Formation		
Shale, slightly sandy, gray, firm to weak	5	816
Shale, sandy, dolomitic, red, some green, weak to partly firm	10	826
Shale, silty, green, partly red, weak, plastic	5	831
Shale, micaceous, silty, red, green; siltstone, dolomitic, buff, red, compact	5	836
Shale, silty, slightly dolomitic, red, green, weak	10	846
Shale, slightly dolomitic, micaceous, silty, red, weak	5	851
Siltstone, dolomitic, red, buff, compact	5	856
Shale, silty, slightly dolomitic, red, green, weak	5	861
Sandstone, silty, dolomitic, some glauconitic specks, buff, gray, very fine, compact	20	881
Shale, silty, sandy, dolomitic, light gray, red, weak; siltstone, dolomitic, micaceous, sandy, buff, compact	7	888
Shale, silty, slightly dolomitic, light gray, weak	3	891
Shale, silty, micaceous, green, weak with sandstone layer, silty, dolomitic, glauconitic, buff, compact	11	902
Shale, silty, dolomitic, light gray, weak	9	911
Sandstone, dolomitic, silty, light gray, green, fine to coarse, compact to mostly incoherent	5	916
Sandstone, light gray, very fine to medium, some coarse, incoherent	10	926
Sandstone, light gray, fine to medium, some coarse, incoherent	5	931
Sandstone, silty, light gray, fine to coarse, incoherent	15	946
Sandstone, silty, light gray, fine, incoherent	5	951
Sandstone, silty, light gray, some black, fine to coarse, incoherent; dolomite, buff, very fine	10	961
Sandstone, silty, light gray, fine to coarse, incoherent	10	971
Sandstone, light gray, fine to coarse, incoherent	15	986
Sandstone, silty, light gray, fine to coarse, incoherent	5	991
Sandstone, dolomitic, light gray, fine to some medium, incoherent to compact	5	996
Sandstone, dolomitic, silty, light brown, very fine to fine, compact	15	1011
Sandstone, dolomitic, green, very fine, compact	5	1016
Sandstone, dolomitic, gray, part buff, fine to medium, compact	5	1021
Sandstone, silty, dolomitic, light gray, fine to coarse, compact to incoherent	5	1026
Sandstone, light gray, fine to coarse	10	1036
Sandstone, dolomitic, silty, light gray, greenish cast, fine to coarse, crumbly to incoherent	10	1046
Sandstone, white, very fine to fine, incoherent	5	1051
Sandstone, light gray, fine to coarse, incoherent	10	1061
Sandstone, very silty, dolomitic, light gray, fine to coarse, incoherent	5	1066
Sandstone, silty, light gray, fine to coarse, incoherent	10	1076
Sandstone, dolomitic, light gray, fine to coarse, compact to mostly incoherent	5	1081
Mt. Simon Sandstone		
Sandstone, light gray, very fine to coarse, incoherent	45	1126
Sandstone, silty, light gray, fine to coarse, incoherent	10	1136
Sandstone, silty, light gray, some with sooty appearance, fine to coarse, incoherent, inclusions	20	1156
Sandstone, light gray, fine to coarse, incoherent; shale, sandy, green between 1178 and 1180 feet	45	1201
Same; sandstone, light buff, extra fine, compact	15	1216
Sandstone, buff, very coarse, incoherent	30	1246
Sandstone, buff, fine to coarse, incoherent; some dolomite, light buff, very fine	15	1261
Sandstone, buff, fine to very coarse, incoherent	65	1326
Sandstone, pink, fine to coarse, incoherent, very fine at base	46	1372

Illinois State Geological Survey Report of Investigations 213
63 p., 11 figs., 2 pls., app., 1960



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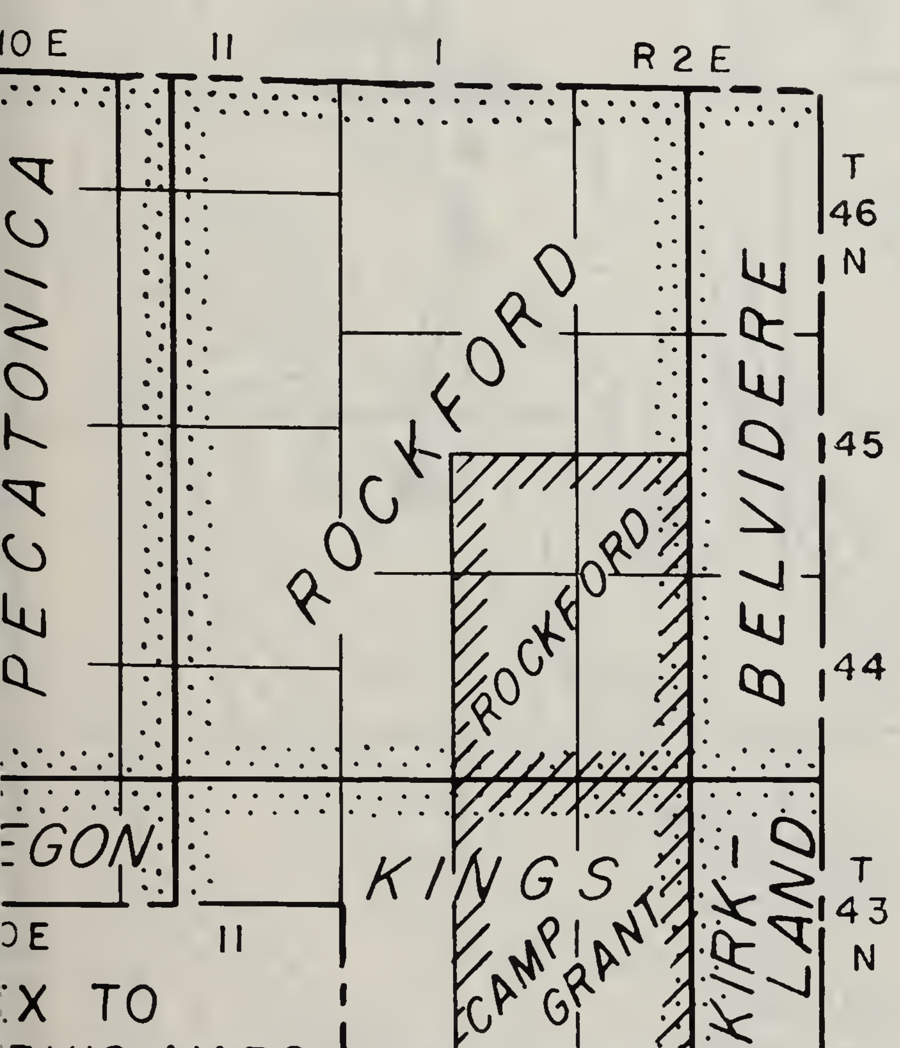
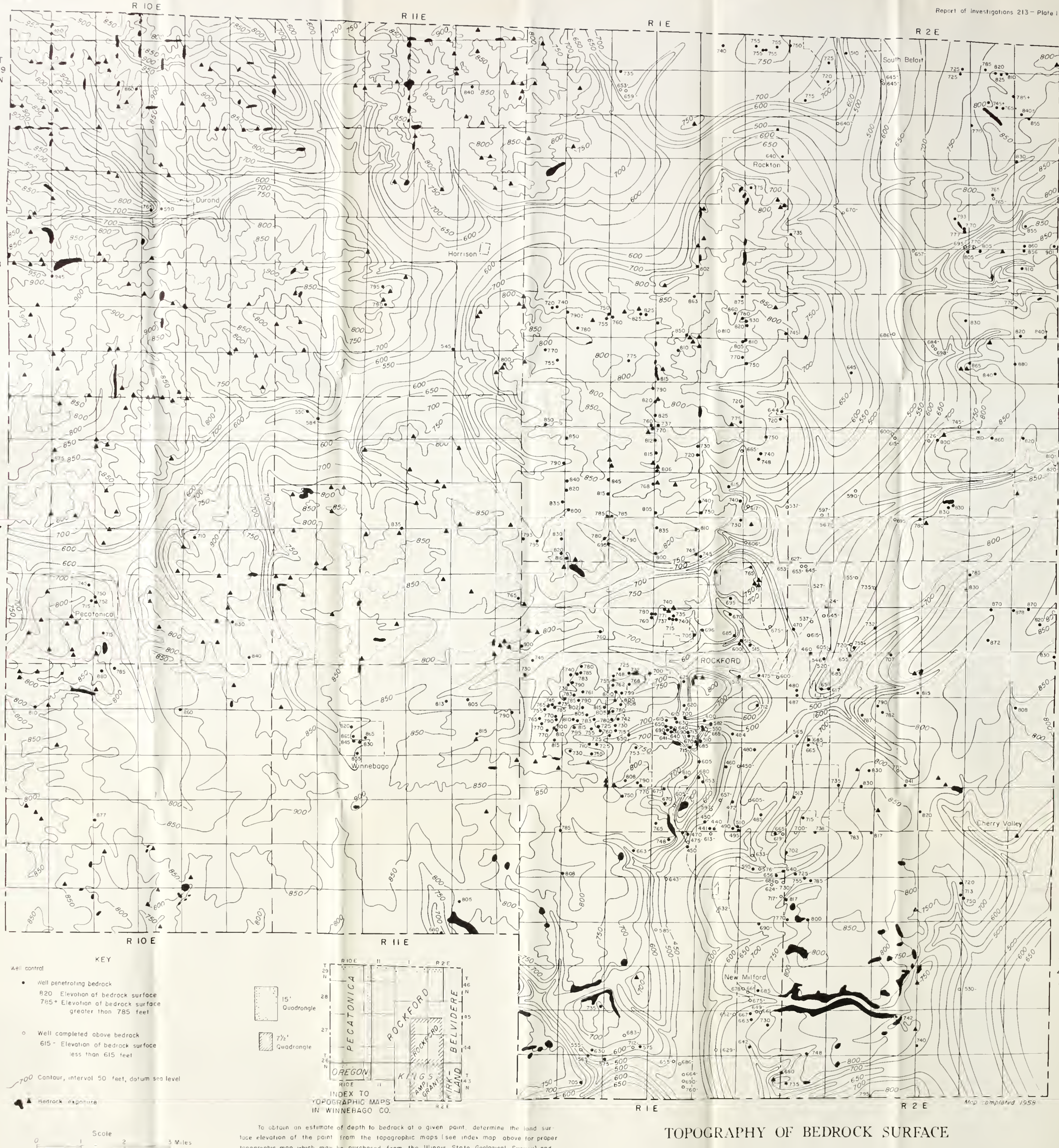


:X TO
PHIC MAPS
EBAGO CO.

depth to bedrock at a given point, determine the lc
om the topographic maps (see index map above f
purchased from the Illinois State Geological Surv
bedrock surface at the same point on the map
the bedrock surface elevation from the land surf
estimated depth to bedrock.



To obtain an estimate of depth to bedrock at a given point, determine the land surface elevation of the point from the topographic maps (see index map above for proper topographic map, which may be purchased from the Illinois State Geological Survey) and determine the elevation of the bedrock surface at the same point on the map of the bedrock topography. Subtract the bedrock surface elevation from the land surface elevation. The difference is the estimated depth to bedrock.

TOPOGRAPHY OF BEDROCK SURFACE OF WINNEBAGO COUNTY

J. E. Hackett

ɪydrologic Units, and Water-Bearing in Winnebago County

WATER-BEARING CHARACTER		GEOHYDROLOGIC UNIT
?ermeable deposits are outwash sand l gravel that are variable in thickness, ture, and extent. Thickest, coarse tured, most continuous deposits of :wash are concentrated in major valleys ng which meltwater drainage was ected away from the ice front. Vari- on in character of outwash causes cor- ponding variations in water-yielding ıracteristics.	GLACIAL DRIFT AQUIFERS	Probabilities for ground-water development range from poor to excellent. Municipal and industrial water supplies come from permeable outwash along Rock Valley at depths of less than 300 feet. Permeable deposits directly below surface in river valleys permit rapid recharge of aquifers. Glacial aquifers used for small water supplies because they are shallow. Ground water in glacial aquifers is harder and higher in iron, nitrates, and sulphates than in underlying bedrock aquifers.
Water-yielding character of Galena, corah, and Platteville is similar. elds water from well developed vertical- oriented joint and fracture systems ere present in Winnebago County.	ORDOVICIAN AQUIFERS	DOLOMITE AQUIFERS Principal source of water supplies for domestic, stock, and other uses. Most of these wells obtain suitable supplies between 20 and 100 feet into the dolomites. Consistent water-yielding character due to extensively developed joint and fracture systems. Water-table conditions may occur in upland areas with thin drift cover whereas artesian conditions predominate in other areas. Aquifers susceptible to pollution, particularly in areas where glacial drift cover is less than 50 feet thick.
Permeable sediments are local basal ıdstone beds. Shale and dolomite in per part of formation generally of little lue as an aquifer.		SANDSTONE AQUIFERS Includes sandstone beds in St. Peter and basal Glenwood Formations. Widespread source of water for supplies up to about 300 gpm per well. Water supply for domestic and stock wells generally withdrawn from upper 50 feet of unit. Artesian conditions except
A widely used aquifer. Water-yielding ıracter depends upon the thickness of : sandstone beds above the basal zone,	ERS	

Generalized Stratigraphic Section, Geohydrologic Units, and Water-Bearing Properties of the Rocks in Winnebago County

Era	System	Series	Formation	Range in thickness (feet)	MATERIAL	WATER-BEARING CHARACTER	GEOHYDROLOGIC UNIT
CENOZOIC		PLEISTOCENE		0–350	Unconsolidated clay, silt, sand, gravel, and boulders deposited as till, outwash, pond water deposits, and loess. Thickest deposits occur in the major valleys where glacial meltwaters were concentrated.	Permeable deposits are outwash sand and gravel that are variable in thickness, texture, and extent. Thickest, coarse textured, most continuous deposits of outwash are concentrated in major valleys along which meltwater drainage was directed away from the ice front. Variation in character of outwash causes corresponding variations in water-yielding characteristics.	GLACIAL DRIFT AQUIFERS: Probabilities for ground-water development range from poor to excellent. Municipal and industrial water supplies come from permeable outwash along Rock Valley at depths of less than 300 feet. Permeable deposits directly below surface in river valleys permit rapid recharge of aquifers. Glacial aquifers used for small water supplies because they are shallow. Ground water in glacial aquifers is harder and higher in iron, nitrates, and sulphates than in underlying bedrock aquifers.
		Unconformity					
PALEOZOIC	ORDOVICIAN	MOHAWKIAN	Galena Dolomite	0–180	Dolomite, yellowish gray to buff or brown, mostly medium to coarsely crystalline, often porous and partly cherty. Chert generally concentrated in basal beds but may be distributed throughout formation.	Water-yielding character of Galena, Decorah, and Platteville is similar. Yields water from well developed vertically oriented joint and fracture systems where present in Winnebago County.	BEDROCK AQUIFERS — ORDOVICIAN AQUIFERS — DOLOMITE AQUIFERS: Principal source of water supplies for domestic, stock, and other uses. Most of these wells obtain suitable supplies between 20 and 100 feet into the dolomites. Consistent water-yielding character due to extensively developed joint and fracture systems. Water-table conditions may occur in upland areas with thin drift cover whereas artesian conditions predominate in other areas. Aquifers susceptible to pollution, particularly in areas where glacial drift cover is less than 50 feet thick.
			Decorah Formation	3–30*	Dolomite, light gray to buff, gray to red speckled, medium to very finely crystalline, silty, slightly cherty, and containing green or brown shale partings.		
			Platteville Dolomite	95–135*	Dolomite, light gray to brown, generally finely crystalline, dense to finely porous, and containing some shale partings. Lower part sandy, locally grading to sandy dolomite at base.		
			Glenwood Formation	0–60*	Interbedded dolomites, shales, and sandstones. Upper beds predominantly sandy, silty, argillaceous, finely crystalline dolomite and partly silty and sandy shale. Lower beds generally fine to coarse-grained silty sandstone.	Permeable sediments are local basal sandstone beds. Shale and dolomite in upper part of formation generally of little value as an aquifer.	SANDSTONE AQUIFERS: Includes sandstone beds in St. Peter and basal Glenwood Formations. Widespread source of water for supplies up to about 300 gpm per well. Water supply for domestic and stock wells generally withdrawn from upper 50 feet of unit. Artesian conditions except where sandstones crop out or are overlain by thin glacial drift. Hydrostatic pressure differences between sandstone aquifers and glacial drift aquifers may result in ground-water leakage in buried valley areas.
			Unconformity				
		CHAZYAN	St. Peter Sandstone	200–360*	Sandstone, fine-to medium - grained, friable, locally silty and argillaceous. White to buff in upper part and pink or red in lower part. Generally contains a basal zone of interbedded cherty conglomerate, quartzitic sandstone, clay, and shale averaging 30 to 40 feet in thickness.	A widely used aquifer. Water-yielding character depends upon the thickness of the sandstone beds above the basal zone, the amount of clay, silt, and fine-grained sand in the permeable, incoherent sandstone beds, and the thickness and character of material of low permeability in the basal zone.	
			Unconformity				
	CAMBRIAN	ST. CROIXAN	Trempealeau Dolomite	0–100*	Dolomite, pinkish to buff, finely crystalline, glauconitic. Contains variable amounts of clay, silt, and sand, with sand content increasing towards base. Locally porous, may contain chalky chert and geodes lined with drusy quartz.	Ground water obtained from crevices and solution openings in dolomite. Distribution and extent of water-yielding openings unknown but locally may serve as a secondary source in wells drilled to deeper aquifers.	BEDROCK AQUIFERS — CAMBRIAN AQUIFERS: Principal bedrock aquifers used by large capacity wells (up to 2000 gpm). Contain fresh water to depths of at least 2000 feet. Principal aquifers are the Ironton-Galesville Sandstone, the basal zone of the Eau Claire Formation, and the Mt. Simon Sandstone. Some water may be provided locally from crevices in Trempealeau Dolomite. Ground water under artesian conditions. Some differences in hydrostatic head between Cambrian aquifers and overlying bedrock aquifers may be present in undeveloped areas. Differences largely equalized in Rockford area where there are numerous uncased wells and large ground-water withdrawals from bedrock aquifers. Largely undeveloped in most of county and below depths of about 1400 to 1600 feet in Rockford area.
			Franconia Formation	60–95	Interbedded shale, sandstone, and dolomite. Shales are red, gray, or green, sandy, silty, and glauconitic. Sandstones are red to green, fine-grained, compact, and glauconitic. Local dolomites are variegated, sandy, silty, and glauconitic.	Permeability of formation is low because of large proportion of tight shale and dense fine-grained sandstone. Small quantities of water may be obtained from crevices in the dense rocks and thin permeable zones in the sandstone beds.	
			Ironton-Galesville Sandstone	75–170	Sandstone, mostly white, fine-to coarse-grained, poorly to well sorted, silty to clean, incoherent to compact. Interbedded with some sandy dolomite that may be restricted to middle and upper part but also found to base of the interval.	Permeable beds of incoherent, clean, well sorted sandstone occur throughout. Variation in permeability and water-yielding characteristics occurs because of variation in character and distribution of lithologies.	
			Eau Claire Formation	350–450	Upper zone: green to red shale, generally dolomitic and silty, with interbedded dolomite and sandstone. Middle zone: sandstone, very fine- to very coarse-grained, generally dolomitic to argillaceous and silty, with interbedded dolomite and shale. Basal zone: sandstone, light yellow to gray, very fine- to very coarse-grained. Sand grains appear "sooty" near base; beds of light to dark gray shale and siltstone occur.	Water-bearing characteristics variable. Principal water-contributing units are the clean, incoherent, medium- to coarse-grained sandstone beds in the lower part. Some ground water may be obtained from the less numerous beds of incoherent sandstone in the middle dolomitic zone. The shaly upper zone of the formation is of low permeability and is not an aquifer.	
			Mt. Simon Sandstone	800–1600	Sandstone, very fine- to very coarse-grained with variable sorting, silty, and mainly incoherent. Beds of conglomerate and thin variegated shale partings occur at irregular intervals. Upper 50 to 250 feet of formation is yellowish gray to pink. Lower part is oxidized red and arkosic at base.	Permeable beds or lenses of well sorted, fine- to coarse-grained friable sandstone may compose 40 percent of the formation. The formation contains several beds of silty, poorly sorted sandstone and numerous thin shale partings of low permeability.	
		Unconformity					
PRE-CAMBRIAN					Crystalline rock. Red granite where penetrated by drilling in the county.	Not an aquifer. The crystalline rocks are of low porosity, are relatively impermeable, and are a barrier to downward movement of ground water from overlying formations.	

*Thickness of formations where unaffected by post-Paleozoic erosion.